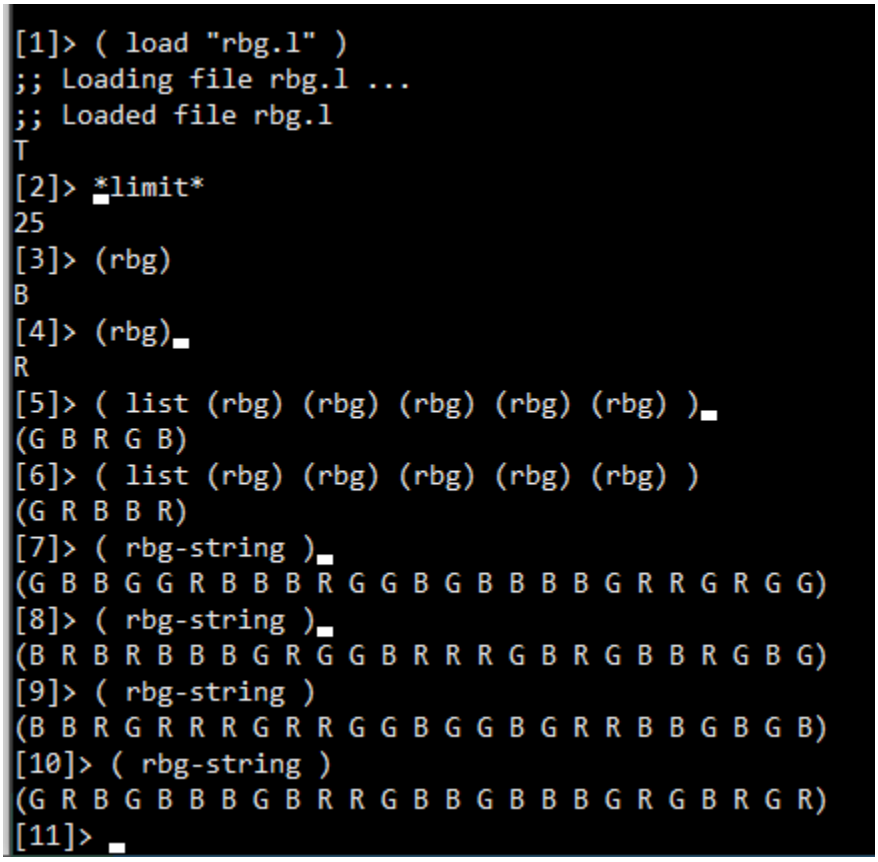
RBG String (Creature) GA Recreation Assignment

Abstract: This late semester assignment is designed to allow students to learn the basic steps of a Genetic Algorithm in Lisp. Broken down into 11 steps, the basics of this type of algorithm is written out in an easily understandable and adaptable way. This was one of the most interesting assignments of the semester.

Task 1: RBG-String

Task 1 Demo:



Task 1 Code:

```
;-----------------------------------------------
; Task 1

( setf *limit* 25 )

( defmethod rbg ()
    ( nth ( random 3 ) '( r b g ) )
)

( defmethod rbg-string ( )
    ( rbg-string-help *limit* )
)

( defmethod rbg-string-help ( num )
    ( cond
        ( ( = num 0 ) () )
        ( t
            ( cons ( rbg ) (rbg-string-help ( - num 1 ) ) )
        )
    )
)

```

Task 2: Mutation

Task 2 Demo:

```
[1]> ( load "rbg.l" )
;; Loading file rbg.l ...
;; Loaded file rbg.l
T
[2]> ( setf colors '(r g b r) )
(R G B R)
[3]> ( mutation colors )
(B G B R)
[4]> colors
(R G B R)
[5]> ( mutation colors )
(R B B R)
[6]> colors
(R G B R)
[7]> ( mutation colors )
(R G R R)
[8]> ( setf s '( r b g g b  r ) )
(R B G G B R)
[9]> ( setf s ( mutation s ) )
(R B G G R R)
[10]> ( setf s ( mutation s ) )
(R B G B R R)
[11]> ( setf s ( mutation s ) )
(R B G B G R)
[12]> ( setf s ( mutation s ) )
(R B G B G B)
[13]> ( setf x ( rbg-string ) )
(B G G R B B B R G G B G B B B B G R R G R G G B R)
[14]> ( setf x ( mutation x ) )
(B G G R B B B B G G B G B B B B G R R G R G G B R)
[15]> ( setf x ( mutation x ) )
(B G G R B B B B G G R G B B B B G R R G R G G B R)
[16]>
```

Task 2 Code:

```
;-----------------------------------------------
; Task 2: Mutation

( defmethod mutation ( ( rbg-str list ) &aux position symbol )
    ( setf position ( random ( length rbg-str ) ) )
    ( setf symbol ( others '( r b g ) ( nth position rbg-str ) ) )
    ( change rbg-str ( pick symbol ) position )
)

( defmethod others ( li obj )
    ( remove obj li )
)

( defmethod change ( li symb pos &aux newLi)
    ( setf newLi ( copy-list li ) )
    ( setf ( nth pos newLi) symb )
    newLi
)

( defmethod pick ( li )
    ( nth ( random ( length li ) ) li)
)
```

Task 3: RBG-String

Task 3 Demo:

```
[1]> ( load "rbg.l" )
;; Loading file rbg.l ...
;; Loaded file rbg.l
T
[2]> ( setf m '( a b c d e f g ) )
(A B C D E F G)
[3]> ( setf f '(t u v w x y z ) )
(T U V W X Y Z)
[4]> ( crossover m f )
(A U V W X Y Z)
[5]> ( crossover m f )
(A B C D X Y Z)
[6]> ( crossover m f )
(A B C D E F Z)
[7]> ( crossover m f )
(A B C W X Y Z)
[8]> m
(A B C D E F G)
[9]> f
(T U V W X Y Z)
[10]> ( setf m ( rbg-string ) )
(R G B G R B B R G B B G G R B B B R G G B G B B B)
[11]> ( setf f ( rbg-string ) )
(B G R R G R G G B R B R B B B G R G G B R R R G B)
[12]> ( crossover m f )
(R G B G R B B R G B B G G R B B B G G B R R R G B)
[13]> ( crossover m f )
(R G B G R B B R G B B R B B B G R G G B R R R G B)
[14]> ( crossover m f )
(R G B G G R G G B R B R B B B G R G G B R R R G B)
[15]> m
(R G B G R B B R G B B G G R B B B R G G B G B B B)
[16]> f
(B G R R G R G G B R B R B B B G R G G B R R R G B)
[17]>
```

Task 3 Code:

```
;-----------------------------------------------
; Task 3 - Crossover

( defmethod crossover ( ( m list ) ( f list ) &aux pos )
    ( setf pos ( + 1 ( random ( length m ) ) ) )
    ( append ( first-n m pos ) ( rest-n f pos ) )
)

( defmethod first-n ( li pos )
    ( subseq li 0 pos )
)

( defmethod rest-n ( li pos )
    ( subseq li pos )
)
```

Task 4: Demos for Mutation and Crossover

Task 4 Demo:

```
[2]> ( crossover-demo )
m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B B G R R G R G G B R B R B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G R B B G B R B R B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G G R G G B R B R B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G R B B R G B B G G R B B B R G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G R B B R G B B G G B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G R B B G B R B R B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B B G R R G R G G B R B R B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G R R G R G G B R B R B B B G R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G R B B R G B B G G R B B B R G G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

m = (B R G B R G B G R B B R G B B G G R B B B R G G B)
x = (B R G B R G B G R B B R G B B G G R B B B R G B R)
f = (G B B B B G R R G R G G B R B R B B B G R G G B R)

NIL
```

Task 4 Code:

```
;-----------------------------------------------------
; Task 4 - Demos fo mutation and Crossover


( defmethod mutation-demo ( &aux s m )
    ( setf s ( rbg-string ) )
    ( dotimes ( i 10 )
        ( format t "s = ~A~%" s )
        ( setf m ( mutation s ) )
        ( format t "m = ~A~%~%" m )
    )
)

( defmethod crossover-demo ( &aux m f x )
    ( setf m ( rbg-string ) )
    ( setf f ( rbg-string ) )
    ( dotimes ( i 10 )
        ( format t "m = ~A~%" m )
        ( setf x ( crossover m f ) )
        ( format t "x = ~A~%" x )
        ( format t "f = ~A~%~%" f)
    )
)
```

Task 5: The Fitness Metric

Task 5 Demo:

```
[1]> ( load "rbg.l" )
;; Loading file rbg.l ...
;; Loaded file rbg.l
T
[2]> ( setf x (rbg-string ) )
(B R G B R G B G R B B R G B B G G R B B B R G G B)
[3]> x
(B R G B R G B G R B B R G B B G G R B B B R G G B)
[4]> ( fitness-r x )
6
[5]> ( fitness-b x )
11
[6]> ( fitness-g x )
8
[7]> ( setf fitness #'fitness-r )
#<STANDARD-GENERIC-FUNCTION FITNESS-R>
[8]> ( funcall fitness x )
6
[9]> ( setf fitness #'fitness-b)
#<STANDARD-GENERIC-FUNCTION FITNESS-B>
[10]> ( funcall fitness x )
11
[11]> ( setf fitness #'fitness-g )
#<STANDARD-GENERIC-FUNCTION FITNESS-G>
[12]> ( funcall fitness x )
8
```

Task 5 Code:

```
;-------------------------------------------------
; Task 5 - The fitness Metric

( defmethod fitness-r ( rbgStr )
    ( count 'r rbgStr )
)

( defmethod fitness-b ( rbgStr )
    ( count 'b rbgStr )
)

( defmethod fitness-g ( rbgStr )
    ( count 'g rbgStr )
)

( defmethod fitness-demo ( &aux x fitness )
    ( setf x ( rbg-string ) )
    ( format t "x = ~A~%" x )
    ( format t "Directly applying the fitness metrics ... ~%" )
    ( format t "fitness-r = ~A~%" ( fitness-r x ) )
    ( format t "fitness-b = ~A~%" ( fitness-b x ) )
    ( format t "fitness-g = ~A~%" ( fitness-g x ) )
    ( format t "Indirectly applying the fitness metrics ... ~%" )
    ( setf fitness #'fitness-r )
    ( format t "fitness-r = ~A~% " )
    ( setf fitness #'fitness-g )
    ( format t "fitness-g = ~A~% " )
    ( setf fitness #'fitness-b )
    ( format t "fitness-b = ~A~% " )
)
```

Task 6: RBG-String

Task 6 Demo:

```
[1]> ( load "rbg.l" )
;; Loading file rbg.l ...
;; Loaded file rbg.l
T
[2]> ( setf rbg ( rbg-string ) )
(B B B B R G R G B R R B G R R R G R B R B G G B B)
[3]> rbg
(B B B B R G R G B R R B G R R R G R B R B G G B B)
[4]> ( setf *fitness* #'fitness-b )
#<STANDARD-GENERIC-FUNCTION FITNESS-B>
[5]> ( setf rbg-i ( new-individual 1 rbg ) )
#<INDIVIDUAL #x1AA91C7D>
[6]> ( individual-number rbg-i )
1
[7]> ( individual-rbg-string rbg-i )
(B B B B R G R G B R R B G R R R G R B R B G G B B)
[8]> ( display rbg-i )
1     (B B B B R G R G B R R B G R R R G R B R B G G B B) 10
NIL
[9]> ( funcall *fitness* rbg )
10
[10]> ( setf r ( random-individual ) )
#<INDIVIDUAL #x1AA72D09>
[11]> ( display r )
0     (R G R R B G B G R G G R G B G B B G R G R G R B R) 6
NIL
[12]> ( setf r ( random-individual ) )
#<INDIVIDUAL #x1AA83805>
[13]> ( display r )
0     (R G R G B R R R B G G B B G G B G R G B B G G R G) 7
NIL
```

```
[4]> ( individual-demo )
0     (B B B G R G B R G R G R G G R G B G G B G B R R R) 8
1     (R G G G R B G G R B B R B R B R R G R R R G B B B) 10
2     (B R G G G R B G G R B R R B G R B G R B R R G R R) 11
3     (B B G R G R G G B R G B B G G G G B B G B B G G G) 3
Fitness of i0 = 8
Fitness of i1 = 10
Fitness of i2 = 11
Fitness of i3 = 3
```

Task 6 Code:

```
;-------------------------------------------------------------
; task 6 - The Individual Class

( defclass individual ()
    (
        ( rbg-string :accessor individual-rbg-string :initarg :rbg-string )
        ( fitness :accessor individual-fitness :initarg :fitness )
        ( number :accessor individual-number :initarg :number )
    )
)

( defmethod random-individual ( &aux rbg )
    ( setf rbg ( rbg-string ) )
    ( make-instance 'individual
        :rbg-string rbg
        :fitness ( funcall *fitness* rbg )
        :number 0
    )
)

( defmethod new-individual ( ( nr number ) ( notes list ) )
    ( make-instance 'individual
        :rbg-string notes
        :fitness ( funcall *fitness* notes )
        :number nr
    )
)

( defmethod display ( ( i individual ) )
    ( display-nnl i ) ( terpri )
)

( defmethod display-nnl ( ( i individual ) )
    ( prin1 ( individual-number i ) )
    ( princ ( filler ( individual-number i ) ) )
    ( prin1 ( individual-rbg-string i ) )
    ( princ " " )
    ( prin1 ( individual-fitness i ) )
    ( princ ( filler ( individual-fitness i ) ) )
)

( defmethod filler ( ( n number ) )
    ( cond
```

```
        ( ( < n 10 ) "     " )
        ( ( < n 100 ) "    " )
        ( ( < n 1000 ) "   " )
        ( ( < n 10000 ) "  " )
        ( ( < n 100000 ) " " )
    )
)

( defmethod fitness-b ( ( i individual ) )
    ( fitness-b ( individual-rbg-string i ) )
)

( defmethod fitness-r ( ( i individual ) )
    ( fitness-r ( individual-rbg-string i ) )
)

( defmethod fitness-g ( ( i individual ) )
    ( fitness-g ( individual-rbg-string i ) )
)

( defmethod individual-demo ( &aux i0 i1 i2 i3 one two three )
    ( setf *fitness* #'fitness-r )
    ( setf i0 ( random-individual ) )
    ( display i0 )
    ( setf one ( rbg-string ) )
    ( setf i1 ( new-individual 1 one ) )
    ( display i1 )
    ( setf two ( rbg-string ) )
    ( setf i2 ( new-individual 2 two ) )
    ( display i2 )
    ( setf three ( rbg-string ) )
    ( setf i3 ( new-individual 3 three ) )
    ( display i3 )
    ( format t "Fitness of i0 = ~A~%" ( funcall *fitness* i0 ) )
    ( format t "Fitness of i1 = ~A~%" ( funcall *fitness* i1 ) )
    ( format t "Fitness of i2 = ~A~%" ( funcall *fitness* i2 ) )
    ( format t "Fitness of i3 = ~A~%" ( funcall *fitness* i3 ) )
    nil
)
```

Task 7: The Population Class

Task 7 Demo:

```
[1]> ( load "rbg.l" )
;; Loading file rbg.l ...
;; Loaded file rbg.l
T
[2]> ( setf p ( initial-population ) )
#<POPULATION #x1A4838F1>
[3]> ( display p )


Generation 0 population ...


1    (B G B G R G G R G B G B B G R G R G R B R R G R G) 6
2    (B R R R B G G B B G G B G R G B B G G R G B R B B) 10
3    (G B R R B G R G R B R G B G G B G R G R B G B G B) 8
4    (G B G B R G G B G R R G B B R R B R B R G B B G B) 10
5    (G B G B R R R B G G G B G B G B B B B B G R G B B) 12
6    (R G G R G B G R G G G B B B G R R B R G R B G R G) 6
7    (G R G R R G G G R B G R G R G B G B G G B G G G G) 4
8    (R B R B B R G G G R R R B G R B G R G G B R G G R) 6
9    (G B G G B B B B R R B B R G R B B B R B G R R G R) 11
10   (R B R G R B B G G B R G R B R R B B R R B G B R R) 9
11   (R G B R G R B R B B G G B B R G B R R R G B B B R) 10
12   (R R R R G G G G B B R B B B B B B B G B R R R R B) 11
13   (R G R G R R G R G R B R B B R G G R G R G B G R G) 4
14   (G R R G B R R R G R B G G G R R G G R G B G G R G) 3
15   (R R B B R B B G B R G R R G B R G B R R R B B G B) 10
```

16 (G R B G B R R B G B B R G G G R R G G B B G G B G) 8

17 (G G B B G R B G B R B G B B R R G R B B G R B B G) 11

18 (B G B G R G R G G G G G B R G B G R G G R R R R R) 4

19 (G G R B R G R B G G G G B R G G B B B G G B R B G) 8

20 (G B G G G B B R B R B G G G B B B B G B R R R B G) 11

21 (R R B G R G G R B B B R B G G B G G R G G R B R G) 7

22 (G B B G B G B G R R R B G R B B B R R B R B R R G) 10

23 (G B R R R R B B R B R R R G R G G B G G R B R R G) 6

24 (G B B G G R G G R B G B G B G R B G B R B R G R B) 9

25 (R G B B B R R R G B B B B G B R B R R B G G B B R) 12

26 (B R G R G R B B R G G R R R B G G R G R B G R R B) 6

27 (R B R G B B G G G R G R B B G R G B B R R R R B R) 8

28 (G G B R B G G G B G B R G G G G G G G R R R R G G R) 4

29 (B B B R B G B G R G G R R R R R R R R B R B B B R) 9

30 (R G B R B R G B B B B B G B R G G G B G R G B R R) 10

31 (B G B G B G B G G B B G B G B B B G G G R B B R G R) 11

32 (G G R R R B B R G B G B B R G G B G G R G B R B B) 9

33 (R R R R G R R G R B G G B B G R R B G B B G R R G) 6

34 (B G G B G R G B B B B B G B B B B R R B G R B G B) 14

35 (G B B R G G G G R R B G R R R G G B R B R R G G B) 6

36 (R R G B G B B G B R G B R R B R R B G B R G R B G) 9

37 (B R R B G R G G G G B R B R G R G R G R R R G G G) 4

38 (R G R R R R G R R R B B R R B G G R R G R R G B R) 4

39 (B R R R G G R B R B G R B G G G G G B B G G B R R) 7

40 (B G R R R G R G G G B R G B R R B B B R G R R R B) 7

41 (B R B R G G G R R G G G R G R R B G R B B G G G R) 5

42 (B G R G G R R B R R R G B G B R R G R G R B G R G) 5

43 (R G B B G G B B B G G B G G G G G G G R G B B R B) 9

44 (R R B R G R G B B R G R B R B B B R B R G R B G B) 10

45 (B R R R R G R G B B G G G G R R G R R R R G G B G) 4

46 (B G G G G R R R G B R G B R G R B G B B R B G R G) 7

47 (G B B R B G B B R B B G R B R G G G G G B B G R G) 10

48 (G R R R B G G B B G R G G R G G G R B B R G G G B G) 6

49 (R G R R R G G R B R B B B G B R B R B R R R R B R) 8

50 (G G R B G G G B B B R R B B G B G G R B R R R B B) 10

51 (B R G G G B G R B R G B B G R B R B G R R G G B R) 8

52 (R G B B G B R G R R R B R G B R G R G R G R G R G) 5

53 (R G R G G R G G B G R R G R G B R B G G R B R B R) 5

54 (G B G G R G R B B G R B R R B B G B G B G R B B R) 10

55 (G R G R G B B G R R R R R R G G G G G B B B B B G) 7

56 (B G G B R G R B G B G R G R R B G R B B B B G G B) 10

57 (R G G G B G G G R G R R R R G R R B B G G B B G R) 5

58 (B G R G R R G G B R R R G B B R G R B R G B G B G) 7

59 (B B B B R B R G B B R R R R B G R G R B R R G B G) 10

60 (R B B R R G B R B B G B G G R G R G B G R G R R G) 7

61 (R B B B R B R R B B B G R B R G R G G R G G B R B) 10

62 (B B B R R R R G B R B R R G R B B G G R G R B B G) 9

63 (B G G B B G R R G G G R G R B G B B B B B G B B B) 12

64 (R G R B G R G R R R R R B B R R R B G B G B B R B) 8

65 (R G B R R G B R R G B G R B R G G B B G B G R G R) 7

66 (B R B B R B R R B B R R G G R R G B B G R R R B G) 9

67 (R R R G B B R R G B B B G B G R R G G R R R R B R) 7

68 (G B R G B R R G R B G R B B G G B B R G B B G R B) 10

69 (G R B B B G G B R B B R B R R B G B G B B R G B G) 12

70 (B B G R G G G R B R G R R B B G R R B B R B G B B) 10

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

72 (G G R R G G B R G R B B G G B R B G G R G B R R R) 6

73 (R B B R R B G B G B R B G G G B G G G R B B G B R) 10

74 (B G B R B R B G G G G R R B B R R G R R R G G G R) 6

75 (G R G B B R G B B R R B G B R B G B R B G G G G B) 10

76 (B R R B R B G R R R R B B R B G R R R G R R R R B) 7

77 (R B R R G R R R B G G G G B R G G G B R B B B G G) 7

78 (R B B B R B G R B B B R R R B R B R R B R G B G R) 11

79 (G B G B G G R G G B B G G G B R R B R G B B G G G) 8

80 (B B B R B G G B B R R R R R B B G B G R G G G B G) 10

81 (R G R B G G G R G B R R R G R R B B G B B B R B R) 8

82 (B B G R R B B B G R G R R G G G R B G R B R G G G) 7

83 (R B G B B G R R R G R R G G R R G B G R B G R G R) 5

84 (G B R R R B R R G B G R G G B B G R G G B B B G R) 8

85 (R G B R G G G G R R B B R G B G G G G B B B G B B) 9

86 (G B B G B G B G R G G B B G R G B R B G G R R G R) 8

87 (B G B B B G R G R R G G B R B R G G B R R R G R R) 7

88 (G R G R R R G G R R B B R G B R R R G R G R G G B) 4

89 (R R R R G R R R B B G G G B G B B G B B G R G R R) 7

90 (R B B B G G B R B G G G G R R R B B G R B G R B G) 9

91 (R R B B G G G R G B G B B G B R G G G G R G G B B) 8

92 (B R B G G G B G R B R B R R B B G B B B R B B R B) 13

93 (B R G B G R B B G G G G G B B G R G G G B B B R B) 10

94 (R G G G R B B B G G G G R R G R R R B R B G R G B) 6

95 (B G R B B R B R B B G R B G G R R B R R G R G G R) 8

96 (B R B B R G G G G B G G R R G R G R G R B G B G R) 6

97 (R B G B R B R G R R G B G G R R B B R G G G G B B) 8

98 (B B B G R G R G R B G G R R R R G R G R R B R G B) 6

99 (R R G B G R R G G B R G G R R G R G R B G B G B R) 5

100 (G B B R R G B G G G B B G R R B G B G R R B R R B) 9

NIL

[4]> (average p)

7.98

[5]> (select-individual p)

#<INDIVIDUAL #x1A424339>

[6]> (display (select-individual p))

92 (B R B G G G B G R B R B R R B B G B B B R B B R B) 13

NIL

[7]> (display (select-individual p))

50 (G G R B G G G B B B R R B B G B G G R B R R R B B) 10

NIL

[8]> (display (select-individual p))

2 (B R R R B G G B B G G B G R G B B G G R G B R B B) 10

NIL

[9]> (setf *select-demo* t)

T

[10]> (display (select-individual p))

the sample of individuals ...

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

22 (G B B G B G B G R R R B G R B B B R R B R B R R G) 10

100 (G B B R R G B G G G B B G R R B G B G R R B R R B) 9

19 (G G R B R G R B G G G G B R G G B B B G G B R B G) 8

86 (G B B G B G B G R G G B B G R G B R B G G R R G R) 8

79 (G B G B G G R G G B B G G G B R R B R G B B G G G) 8

23 (G B R R R R B B R B R R R G R G G B G G R B R R G) 6

79 (G B G B G G R G G B B G G G B R R B R G B B G G G) 8

the most fit of the sample ...

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

NIL

[11]> (display (select-individual p))

the sample of individuals ...

60 (R B B R R G B R B B G B G G R G R G B G R G R R G) 7

86 (G B B G B G B G R G G B B G R G B R B G G R R G R) 8

69 (G R B B B G G B R B B R B R R B G B G B B R G B G) 12

20 (G B G G G B B R B R B G G G B B B B G B R R R B G) 11

24 (G B B G G R G G R B G B G B G R B G B R B R G R B) 9

44 (R R B R G R G B B R G R B R B B B R B R G R B G B) 10

75 (G R G B B R G B B R R B G B R B G B R B R B G G G G B) 10

17 (G G B B G R B G B R B G B B R R G R B B G R B B G) 11

the most fit of the sample ...

69 (G R B B B G G B R B B R B R R B G B G B B R G B G) 12

69 (G R B B B G G B R B B R B R R B G B G B B R G B G) 12

NIL

[12]> (display (select-individual p))

the sample of individuals ...

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

46 (B G G G G R R R G B R G B R G R B G B B R B G R G) 7

70 (B B G R G G G R B R G R R B B G R R B B R B G B B) 10

15 (R R B B R B B G B R G R R G B R G B R R R B B G B) 10

35 (G B B R G G G G R R B G R R R G G B R B R R G G B) 6

24 (G B B G G R G G R B G B G B G R B G B R B R G R B) 9

39 (B R R R G G R B R B G R B G G G G G B B G G B R R) 7

82 (B B G R R B B B G R G R R G G G R B G R B R G G G) 7

the most fit of the sample ...

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

71 (G R B G B G B G G G R R B B B G B R R B R B G G B) 10

NIL

[13]> (display (select-individual p))

the sample of individuals ...

28 (G G B R B G G G B G B R G G G G G G R R R R G G R) 4

21 (R R B G R G G R B B B R B G G B G G R G G R B R G) 7

56 (B G G B R G R B G B G R G R R B G R B B B B G G B) 10

49 (R G R R R G G R B R B B B G B R B R B R R R R B R) 8

26 (B R G R G R B B R G G R R R B G G R G R B G R R B) 6

5 (G B G B R R R B G G G B G B G B B B B B G R G B B) 12

86 (G B B G B G B G R G G B B G R G B R B G G R R G R) 8

70 (B B G R G G G R B R G R R B B G R R B B R B G B B) 10

the most fit of the sample ...

5 (G B G B R R R B G G G B G B G B B B B B G R G B B) 12

5 (G B G B R R R B G G G B G B G B B B B B G R G B B) 12

NIL

[14]> (population-demo)

Generation 0 population ...

1 (R G G R B R G R B G B B B B B G G G R R B B R G B) 10

2 (B B B B G R R G R G R G G R B R G R B B G G R G G) 7

3 (B B G G B R R B G B G B B R B R R R R R R B G B B) 11

4 (B G B B G B G G G G B R B B G R B R B B G B B B B) 14

5 (R R R R G B R R G R R R R R G B R B B R G B R G R) 5

6 (G G R B B R G G G B B R B B B B R B R G G G G R G) 9

7 (B R G G R R G B G R G B R G B G G G R R B B B B G) 8

8 (B R R G R G R B G R G B B R R G B R R R R R R R R) 5

9 (G B G R B R G G G B R B B G G G G G G R B R G R R G) 6

10 (B R G R R R G B R G B G G G G B G B G G R B R G R) 6

11 (G B R R B G R G G B G R G R R B R B G R B G R G G) 6

12 (G R G B R G G G B R R G R R G G G G B G B G B R G) 5

13 (R R G R G R B G B G G G R B B R R G G R R G R R G) 4

14 (G B B R G B B R B B B G B B B R B R G B B G G B G) 14

15 (G R B R G G G R G R R B G G R B G G G R R G R B G) 4

16 (G G G R B R R B G R B B R B B B G B G R G B B G R) 10

17 (R B R R R G G B G G R B R R B G B R B G G B R G G) 7

18 (R R B R B R R R G G R B B G G R G B B G R R B B R) 8

19 (B G R G G B B R B G B G R B G G G B G B R R G B G) 9

20 (G G G R B B R G B R G B B B B B G G G B B R R B G G) 11

21 (R B G B G G R R G R G B B G R G B B R R B B G R B) 9

22 (R G B G B B R G G G B R B B G B R B B R G R G B R) 10

23 (B B R B G R B B R B R B R R G R R R B G B R R R R) 9

24 (G R R B B R B R G G R B G R B R G R G R R R R G B) 6

25 (B R G G B R R G R B R R B R R R B B B G G G R G R) 7

26 (R R B R G G G R R B B B R R G G B G R G G G R B B) 7

27 (B B R R B B R B B R G B G B G G G R G G G B G R G) 9

28 (G R R G R B R B B G R B R B B G B R B B G G B R R) 10

29 (G R B R G B R R G G B R R G B G B R R G G B R G G) 6

30 (G B G B R R B B R R G G B R G B G R B G G G G B G) 8

31 (B R B R G G B R B G R B G R R B B R R G R R G R R) 7

32 (B G B B B R B B R R B B G G R R B B G G B R R G B) 12

33 (R G R R G B B R G R R R B R B G R B B B R G G B R) 8

34 (G B B G B G R B B G G G R G B B R B R G B B B G R) 11

35 (G R B R B R B B R B R R R R B B G R G R B G G G G) 8

36 (G R B R B R G B G R G B B R G R R R G B B G R B G) 8

37 (G B R B G G G G R B B R G G G R B G B B R B B R B) 10

38 (R G G G B G R G G G B B G R B R G G B B B B B G R) 9

39 (B R G G G R B G G B B G R R B G G R G B R G G B R) 7

40 (G B B G G G G R B R B R R R G R G B B B G R R R G) 7

41 (R R G B B R B G G R R G R G R G R B G G B G R B R) 6

42 (G R B G G B R R G B G B R G R B B B G B G G G R G) 8

43 (G B B G B B G B G R B R R G R G G G R G B G R R R) 7

44 (B B G R B R G G B G B R B B R B G B R B B G G R B) 12

45 (G B G B G B R G B R G B R B R G R B R R R R G G R) 7

46 (G B G B R B R B B B B G G B R B B B B B B R G G G R) 13

47 (R G B B G B B B G G G G R G R R R R G G R B R R R) 6

48 (B B R R G G R G G R G R R R B B G G G G G R R R R R) 4

49 (B G G G B R B R R R R R G G B G B B R G G B G R B) 8

50 (B G G R R G B G R G G B B R R G R R B G G G G R R) 5

51 (B R G B B B B G R B B B G R R B B G G R R G R G R) 10

52 (B R G B B R B B B R B R G R R R G B G R B G R R B) 10

53 (R G G B B G B G R R R B R B B G G B R R G R G B G) 8

54 (B G R B B R G R G G G R G R G G G R B B R G G G B) 6

55 (G B R B R G G B R B G R G G B G G R G B B G G B B) 9

56 (G G B B G B G R G R B R R B B B B B G B G R G G G) 10

57 (B G G G R R B B R R B R G G B R G B B G G G R R B) 8

58 (B R G B G B G G B G B G G G G G G G R R R R B B B R) 8

59 (B B G B R R G G B R B G B R R G R R B B B R R G G) 9

60 (R R B B B R B R G R R G R R B R R G R G G B B G B) 8

61 (G R G R G G G B R B G G R B B R G G B B G B R R R) 7

62 (R B B G B B B R G R G B B B G R R R R R R G B B B) 11

63 (G B G R B R R G R G R R G R B R B B R R B G R R G) 6

64 (B B B B R R B B R R G G B R G G R R B B R B G R R) 10

65 (R R B B G R R G R B G G G R G R B G G B R G R G G) 5

66 (R G B R R R R B B B R G G G B R G G B B R R G R R) 7

67 (B R R B R G G R B G R G R G R R R B G B R B G G R) 6

68 (R B R B R R G G R R B R R G G R R R R G B R G G G) 4

69 (G G B B R R R B B R R B R R B R R G G R B G G B B) 9

70 (G B G G R G B R R B G B R R B B B R G R G R G G R) 7

71 (R G R B B G B G R R B B B R G G B R R B R B G B G) 10

72 (G B G R G R R G B B B G R B B G G B G G G G R R B) 8

73 (R B B G G B R R B G R R R G B R B B G R R G B B B) 10

74 (G R G R B R R G G G R B G B R B R B G G B G G B R) 7

75 (R B B B R R R B G R G B B R G R R G B G R B B R R) 9

76 (R R R G B R G B B G R B B R R R B R R B B G R G G) 8

77 (R R R B B R R B B R B R G G R B B B G R R B R G B) 10

78 (R R B G R R B R G B G R R G R R R G B R G G G G B) 5

79 (G G R B G R B R G B B B G R G B B B R B G B R B B) 12

80 (R R G G G G G G R G R R R R R G G B G R B R G G B) 3

81 (R B R R R G B B B R B B G B B R B R G B B R R G B) 12

82 (G G B G R B B B B B R R R G R R R B G B B R R B G) 10

83 (G G G G R B G B R B B G G G G R G B R G B B G G R) 7

84 (B G B B R R G R B G G G B B R B R G G R G G G B G) 8

85 (R G R B G B B B G G R B B R R R G G R B R G G R R) 7

86 (R B B R G R R B B G G B B B B B G B B G B R R B R) 13

87 (B B B B G B B R R R B G G B G R R B G G R B R B G) 11

88 (R B B R R B G R R B G R G R G B R B B B G B B R R) 10

89 (G G G R B G G B G G R G R R R B G B G G G R R G R) 4

90 (R B B G R G R G B G G B R R B B R B B G R G R B G) 9

91 (R B B B R R R R B G R R G G R B B B R B R R R R G) 8

92 (R R G G G B B R B B G B R R R G G R B B R R B B R) 9

93 (R G G B G B R G R B R B B R R B B G R B B B R R R) 10

94 (B G B B B R B R G B G G B R G G R B G B G G B G R) 10

95 (G B R R B R B B R R B R B G G G G G R R G B B G B) 9

96 (R R R G R R B G G B R R B G G R G R B B B B G R G) 7

97 (R R G B R G G G G G G G G G R R G R G R R G G R B) 2

98 (B G R B R G R G B B R B G G B B R B R B R B G B R B B) 12

99 (G G R G R B B B B R R G R G R G G B B B B G R G B) 9

100 (R B B G R B R G R B G B R B G R B B B G B G B G R) 11

average fitness = 8.21

Sampling ...

the sample of individuals ...

65 (R R B B G R R G R B G G G R G R B G G B R G R G G) 5

39 (B R G G G R B G G B B G R R B G G R G B R G G B R) 7

7 (B R G G R R G B G R G B R G B G G G R R B B B B G) 8

73 (R B B G G B R R B G R R R G B R B B G R R G B B B) 10

11 (G B R R B G R G G B G R G R R B R B G R B G R G G) 6

80 (R R G G G G G G R G R R R R R G G B G R B R G G B) 3

58 (B R G B G B G G B G B G G G G G G R R R R B B B R) 8

14 (G B B R G B B R B B B G B B B R B R G B B G G B G) 14

the most fit of the sample ...

14 (G B B R G B B R B B B G B B B R B R G B B G G B G) 14

Sampling ...

the sample of individuals ...

48 (B B R R G G R G G R G R R R B B G G G G R R R R R) 4

26 (R R B R G G G R R B B B R R G G B G R G G G R B B) 7

26 (R R B R G G G R R B B B R R G G B G R G G G R B B) 7

5 (R R R R G B R R G R R R R R G B R B B R G B R G R) 5

34 (G B B G B G R B B G G G R G B B R B R G B B B G R) 11

25 (B R G G B R R G R B R R B R R R B B B G G G R G R) 7

100 (R B B G R B R G R B G B R B G R B B B G B G B G R) 11

20 (G G G R B B R G B R G B B B B B G G B B R R B G G) 11

the most fit of the sample ...

34 (G B B G B G R B B G G G R G B B R B R G B B B G R) 11

Sampling ...

the sample of individuals ...

42 (G R B G G B R R G B G B R G R B B B G B G G G R G) 8

75 (R B B B R R R B G R G B B R G R R G B G R B B R R) 9

55 (G B R B R G G B R B G R G G B G G R G B B G G B B) 9

59 (B B G B R R G G B R B G B R R G R R B B B R R G G) 9

67 (B R R B R G G R B G R G R G R R R B G B R B G G R) 6

79 (G G R B G R B R G B B B G R G B B B R B G B R B B) 12

70 (G B G G R G B R R B G B R R B B B R G R G R G G R) 7

6 (G G R B B R G G G B B R B B B B R B R G G G G R G) 9

the most fit of the sample ...

79 (G G R B G R B R G B B B G R G B B B R B G B R B B) 12

NIL

Task 7 Code:

```
;-------------------------------------------------
; Task 7 - The Population Class

( defconstant *population-size* 100 )
( defconstant *selection-size* 8 )
( setf *fitness* #'fitness-b )

( defclass population ()
    (
        ( individuals :accessor population-individuals :initarg :individuals )
        ( generation :accessor population-generation :initform 0 )
    )
)

( defmethod size ( ( p population ) )
    ( length ( population-individuals p ) )
)

( defmethod display ( ( p population ) )
    ( terpri ) ( terpri )
    ( princ "Generation " )
    ( prin1 ( population-generation p ) )
    ( princ " population ..." )
    ( terpri ) ( terpri )
    ( dolist ( i ( population-individuals p ) )
        (display i )
    )
    ( terpri )
)

( defmethod initial-population ( &aux individuals )
    ( setf individuals () )
    ( dotimes ( i *population-size* )
        ( push ( new-individual ( + i 1 ) ( rbg-string ) ) individuals )
    )
    ( make-instance 'population :individuals ( reverse individuals ) )
)

( defmethod average ( ( p population ) &aux ( sum 0 ) )
    ( dolist ( i ( population-individuals p ) )
        ( setf sum ( + sum ( funcall *fitness* i ) ) )
    )
    ( / ( float sum ) *population-size* )
```

```
)

( setf *select-demo* nil )

( defmethod select-individual ( ( p population )
    &aux i candidates rn )
    ( setf candidates ( select-individuals p ) )
    ( setf mfi ( most-fit-individual candidates ) )
    ( if *select-demo* ( select-demo-helper candidates mfi ) )
    mfi
)

( defmethod select-individuals ( ( p population )
    &aux individuals candidates rn )
    ( setf individuals ( population-individuals p ) )
    ( setf candidates () )
    ( dotimes ( i *selection-size* )
        ( setf rn ( random *population-size* ) )
        ( push ( nth rn individuals ) candidates )
    )
    candidates
)

( defmethod most-fit-individual ( ( l list ) &aux max-value max-individual )
    ( setf max-value 0 )
    ( setf max-individual () )
    ( dolist ( i l )
        ( if
            ( > ( funcall *fitness* i ) max-value )
            ( let ()
                ( setf max-value ( funcall *fitness* i ) )
                ( setf max-individual i )
            )
        )
    )
    max-individual
)

( defmethod select-demo-helper ( ( l list ) ( i individual ) )
    ( princ "the sample of individuals ..." ) ( terpri )
    ( mapcar #'display l )
    ( terpri )
    ( princ "the most fit of the sample ... " ) ( terpri )
    ( display i )
    ( terpri )
```

```
    nil
)

( defmethod population-demo ( &aux p )
    ( setf p ( initial-population ) )
    ( display p )
    ( format t "average fitness = ~A~%~%" ( average p ) )
    ( setf *select-demo* t )
    ( format t "Sampling ...~%~%" )
    ( select-individual p ) ( terpri )
    ( format t "Sampling ...~%~%" )
    ( select-individual p ) ( terpri )
    ( format t "Sampling ...~%~%" )
    ( select-individual p ) ( terpri )
)
```

Task 8: Incorporating Mutation

Task 8 Demo:

```
[1]> ( load "rbg.l" )
;; Loading file rbg.l ...
;; Loaded file rbg.l
T
[2]> ( setf i ( random-individual ) )
#<INDIVIDUAL #x1A3F2F8D>
[3]> ( display i )
0    (B G B G R G G R G B G B B G R G R G R B R R G R G) 6
NIL
[4]> ( display ( mutate i ) )
0    (B G B G R G B R G B G B B G R G R G R B R R G R G) 7
NIL
[5]> ( display i )
0    (B G B G R G G R G B G B B G R G R G R B R R G R G) 6
NIL
[6]> ( display ( mutate i ) )
0    (B G B G R G G R G B G B B G B G R G R B R R G R G) 7
NIL
[7]> ( display i )
0    (B G B G R G G R G B G B B G R G R G R B R R G R G) 6
NIL
[8]> ( display ( mutate i ) )
0    (B R B G R G G R G B G B B G R G R G R B R R G R G) 6
NIL
[9]> ( display ( mutate i ) )
0    (B G B G R G G G G B G B B G R G R G R B R R G R G) 6
```

NIL

[10]> (display (mutate i))

0 (B G B G R G G R G B G B B G R G R G R B R R B R G) 7

NIL

[11]> (display (mutate i))

0 (B G B G B G G R G B G B B G R G R G R B R R G R G) 7

NIL

[12]> (display (mutate i))

0 (B G B G R G G R G B G B B G B G R G R B R R G R G) 7

NIL

[13]> (display (mutate i))

0 (B G B G R G R R G B G B B G R G R G R B R R G R G) 6

NIL

[14]> (mutate-demo)

0 (B G G R G B R B B G B R R B G R G R B R G B G G B) 9

0 (B R G R G B R B B G B R R B G R G R B R G B G G B) 9

0 (B R G R G B R B B G B R R B G R G R B R G G G G B) 8

0 (R R G R G B R B B G B R R B G R G R B R G G G G B) 7

0 (R R G R G B R B B G B B R B G R G R B R G G G G B) 8

0 (R R G R G B R B B R B B R B G R G R B R G G G G B) 8

0 (R R G R G B R B B R B B R B G R B R B R G G G G B) 9

0 (R R G R G G R B B R B B R B G R B R B R G G G G B) 8

0 (R R G R G G R B B R B B R B G R B R G R G G G G B) 7

0 (R R G R G G R B B R B R R B G R B R G R G G G G B) 6

0 (G R G R G G R B B R B R R B G R B R G R G G G G B) 6

0 (G R G R G G R B B R B R R B G R B R G R B G G G B) 7

0 (G R G R G G R B B B B R R B G R B R G R B G G G B) 8

0 (G R G R G G R B B B B R R B G R R R G R B G G G B) 7

```
0    (G R G R G G R B B B B R R G G R R R G R B G G G B) 6
0    (G R G R G G R B B B B R R G G R R R R R B G G G B) 6
0    (G R G R G G R B B R B R R G G R R R R R B G G G B) 5
0    (G R G R G G R B B R B R R R G R R R R R B G G G B) 5
0    (G R G R G G R R B R B R R R G R R R R R B G G G B) 4
0    (G R G R G G R R G R B R R R G R R R R R B G G G B) 3
0    (G B G R G G R R G R B R R R G R R R R R B G G G B) 4
NIL
[15]> ( maybe-mutate-demo )
0    (R B G G G B G B G B B B B B G R G B B R G G R G B) 11
0    (R B G G G B G B G B B B B B G R G B B R G G B G B) 12    *
0    (R B G G G B G B G B B B B B G R G B B R G G B G B) 12
0    (R B G G G B G B G B B B B B G R G B B R G G B G B) 12
0    (R B G G G B G B G B B B B B G R G B B R G G B G B) 12
0    (R B G G G B G B G B B B B B G R G B B R G G B G B) 12
0    (R B G G G B G B G B B B B B G R G B R R G G B G B) 11    *
0    (R B G G G B G B G B B B B B G R G B R R G R B G B) 11    *
0    (R B G G G B G B G B B B B B G R G B R R G R B G B) 11
0    (R B G G G B G B G B B B B B G R G B R R G R B G B) 11
0    (R B G G G B G B G B B B B B G R G B R R G R B G B) 11
0    (R B G G G B G B G B B B B B G R G B R R G R B G B) 11
0    (R B G G G B G B G B B B B B G R G B R R G R B G B) 11
0    (R B G G G B G B G R B B B B G R G B R R G R B G B) 10    *
0    (R B G G G B G B G R B B B G G R G B R R G R B G B) 9    *
0    (R B G G G R G B G R B B B G G R G B R R G R B G B) 8    *
0    (R B G G G R G B G R B B B G G R G B R R G R B G R) 7    *
0    (R B G R G R G B G R B B B G G R G B R R G R B G R) 7    *
0    (R B G R G R G B G R B B B G G R G B R R G R B G R) 7
```

0 (R B G R G R G B G R B B B G G R G B R R G R B G R) 7

0 (R B G R G R G B G R R B B G G R G B R R G R B G R) 6 *

NIL

Task 8 Code:

```
;-----------------------------------------
; Task 8 Incorporating Mutation

( defmethod mutate ( ( i individual ) &aux mutation )
    ( setf mutation ( mutation ( individual-rbg-string i ) ) )
    ( make-instance 'individual
        :number ( individual-number i )
        :rbg-string mutation
        :fitness ( funcall *fitness* mutation )
    )
)

( defconstant *pc-m* 50)

( defmethod maybe-mutate ( ( i individual ) )
    ( if ( <= ( + 1 ( random 100 ) ) *pc-m* )
        ( mutate i )
        i
    )
)

( defmethod mutate-demo ()
    ( setf i ( random-individual ) )
    ( display i )
    ( dotimes ( x 20 )
        ( setf i ( mutate i ) )
        ( display i )
    )
)

( defmethod maybe-mutate-demo ()
    ( setf i ( random-individual ) )
    ( display i )
    ( dotimes ( x 20 )
        ( setf n ( maybe-mutate i ) )
        ( display-nnl n )
        ( if ( not ( equal n i ) ) ( princ " *" ) )
```

```
        ( terpri )
        ( setf i n )
    )
)
```

Task 9: Copy

Task 9 Demo:

[1]> (load "rbg.l")

;; Loading file rbg.l ...

;; Loaded file rbg.l

T

[2]> (perform-copies-demo)

Generation 1 population ...

----------the sample of individuals ...

62 (B B G R R R B B G G G R R G G R B B R G R B R G R) 7

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

6 (G G R B G G R B R R B G R B G R B R R G R R B B G) 7

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

50 (G R B B R R B B G R B R R G B R G R R G B R G R G) 7

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

75 (G B G B R G G G R B R G R R R R B G G B B G G R B) 7

84 (B B B G B R B R R B G B G R R G G R G B B B R R R) 10

the most fit of the sample ...

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

Selected individual =

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

Possibly muted individual =

94 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

Renumbered individual =

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

----------the sample of individuals ...

57 (R G G R G R R B G G G R B R B G R G R B R B R B R) 6

72 (B G B G R B B G G R G R G R G B R G B B B G G B B) 10

68 (R G G R R R R R B R G B B B R B R B G R G R R B B) 8

27 (R R R B G G B G B G R G B G R G G G B G G R G R B) 6

47 (G R G B R B G B G R R R G R B G G G R R R B R B R) 6

29 (R G R R R R R B R R G R B B G R R G R G B B G B G) 6

68 (R G G R R R R R B R G B B B R B R B G R G R R B B) 8

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

the most fit of the sample ...

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

Selected individual =

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

Possibly muted individual =

67 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

Renumbered individual =

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

----------the sample of individuals ...

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

95 (G B R G G R G G R G R B G R B G G B G R R G G B B) 6

28 (B G G G R R R B G B G G R B B G B G B G R B G R B) 9

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

89 (G G B G R G R R G R G G G G B R G B R B R B B B B) 8

21 (R G B R B G R B G R G G G B B G B G R B R R R R R) 7

85 (B R G B G B G B R B G B B G B G G B R B G B R G B) 12

81 (B R R G B R R G B R B R R G B B R G G R G G G G B) 7

the most fit of the sample ...

85 (B R G B G B G B R B G B B G B G G B R B G B R G B) 12

Selected individual =

85 (B R G B G B G B R B G B B G B G G G B R B G B R G B) 12

Possibly muted individual =

85 (B R G B G B G B R B G B B G R G G G B R B G B R G B) 11

Renumbered individual =

3 (B R G B G B G B R B G B B G R G G G B R B G B R G B) 11

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

----------the sample of individuals ...

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

36 (G G B B R R B R G G R R R G R G R R G G G R R G B) 4

16 (G B G B B B G R G R G R G B G R B R G G G B R G B B) 8

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

21 (R G B R B G R B G R G G G B B G B G R B R R R R R) 7

83 (B B B B G G B G G G B B R R R R G R R R R G G B G) 8

73 (G G B R G B G B G B R R R G R R B B G B B G R G G) 8

the most fit of the sample ...

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

Selected individual =

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

Possibly muted individual =

87 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

Renumbered individual =

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

---the sample of individuals ...

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

23 (G B G B R R R R G B G B B R G B G R B G B R G R B) 9

32 (B R G R B R R R G R G G B R B R R R G R R B B G B) 7

77 (G G R B G B R G B R R R G G G G G R R G G B R G R) 4

38 (G G R B R R R G G B B B G G R G B R G G B B R G B) 8

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

4 (G R G B R G R G R G G R G B G G B G B R R R R G G) 4

31 (B R G B B B G R B G B R R R G B R G R B B R R B G) 10

the most fit of the sample ...

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Selected individual =

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Possibly muted individual =

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Renumbered individual =

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

----------the sample of individuals ...

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

10 (B R R G R R R R G R G B R R B B R R R B B B R B R) 8

80 (B R R R R G B R B R G B G B B G G G B R G R B G B) 9

12 (R R R R B B R B G R R G R R R G R R B R G G R B B) 6

43 (B B B B B G R B B R G B G G G G G B G R G R G G G) 9

20 (R R B R B B B R B B B G R R G G G B B G G B G G G B) 10

85 (B R G B G B G B R B G B B G B G G G B R B G B R G B) 12

the most fit of the sample ...

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

Selected individual =

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

Possibly muted individual =

45 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

Renumbered individual =

6 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

6 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

----------the sample of individuals ...

79 (B R G G B B B B B B R R R B R G G B B G G R G G G) 10

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

80 (B R R R R G B R B R G B G B B G G G B R G R B G B) 9

94 (G B G B B B B B R G G G R B B B G R G R B R B G G G) 10

99 (R B R G B B B B R G B G B G R R R G G G R G R B G R) 7

27 (R R R B G G B G B G R G B G R G G G B G G R G R B) 6

the most fit of the sample ...

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Selected individual =

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Possibly muted individual =

5 (B B R G B G B R B G B R R G G R G R G B R B B R B) 10

Renumbered individual =

7 (B B R G B G B R B G B R R G G R G R G B R B B R B) 10

Generation 1 population ...

1 (G B G B B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

6 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

7 (B B R G B G B R B G B R R G G R G R G B R B B R B) 10

----------the sample of individuals ...

31 (B R G B B B G R B G B R R R G B R G R B B R R B G) 10

24 (G B R B G R G G G G B R B R B R G B G G B G B R R) 8

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

4 (G R G B R G R G R G G R G B G G B G B R R R R G G) 4

15 (G B B G B G B G R R G R R G B R B R G R B B G R R) 8

23 (G B G B R R R R G B G B B R G B G R B G B R G R B) 9

52 (G B R B B B B B R B R R G G G R B B R R R G B R R R) 9

69 (G B B B B R B G G G B G G G R B G G G G R G G G B) 8

the most fit of the sample ...

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

Selected individual =

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

Possibly muted individual =

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

Renumbered individual =

8 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

6 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

7 (B B R G B G B R B G B R R G G R G R G B R B B R B) 10

8 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

----------the sample of individuals ...

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

15 (G B B G B G B G R R G R R G B R B R G R B B G R R) 8

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

49 (R R R G G R B B R G G B G G G B R B B G R R G G G) 6

9 (R G R B B G B R G G R G B R R G G B B R G B R B B) 9

9 (R G R B B G B R G G R G B R R G G B B R G B R B B) 9

97 (G B B G R G G R G B R G R B G R R G G R G R G B G) 5

the most fit of the sample ...

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

Selected individual =

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

Possibly muted individual =

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

Renumbered individual =

9 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

6 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

7 (B B R G B G B R B G B R R G G R G R G B R B B R B) 10

8 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

9 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

----------the sample of individuals ...

89 (G G B G R G R R G R G G G G B R G B R B R B B B B) 8

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

6 (G G R B G G R B R R B G R B G R B R R G R R B B G) 7

9 (R G R B B G B R G G R G B R R G G B B R G B R B B) 9

14 (G B R G G R R G G R B B B G R R G R B R R R R B R) 6

the most fit of the sample ...

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

Selected individual =

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

Possibly muted individual =

66 (R R B R B G B R R G G R G B B R B G B R B G B R G) 9

Renumbered individual =

10 (R R B R B G B R R G G R G B B R B G B R B G B R G) 9

Generation 1 population ...

1 (G B G B B B B R G G G R B R B G R G R B R B G G G) 9

2 (R B R G R B G B G G B G G B R G R G B R G B B B B) 10

3 (B R G B G B G B R B G B B G R G G B R B G B R G B) 11

4 (B R G R B R G R R G G R R B R B R G G B R B B R B) 8

5 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

6 (B B B G R R G B B B R R B R B G G R B G B G R G B) 11

7 (B B R G B G B R B G B R R G G R G R G B R B B R B) 10

8 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

9 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

10 (R R B R B G B R R G G R G B B R B G B R B G B R G) 9

Task 9 Code:

```
;-----------------------------------------------------------
; task 9: Copy

( setf *copy-demo* nil )

( defconstant *pc-c* 40 )

( defmethod perform-copies ( ( cp population ) ( np population ) )
    ( dotimes ( i ( nr-copies ) )
        ( perform-one-copy cp np )
    )
)

( defmethod nr-copies ()
    ( * ( / *pc-c* 100 ) *population-size* )
)

( defmethod perform-one-copy ( ( cp population ) ( np population )
    &aux x m mm new-i )
    ( setf m ( select-individual cp ) )
    ( if *copy-demo* ( format t "Selected individual = ~%" ) )
    ( if *copy-demo* ( display m ) )
    ( setf mm ( maybe-mutate m ) )
    ( if *copy-demo* ( format t "Possibly muted individual = ~&" ) )
    ( if *copy-demo* ( display mm ) )
    ( setf ( individual-number mm ) ( + 1 ( size np ) ) )
    ( if *copy-demo* ( format t "Renumbered individual = ~&" ) )
    ( if *copy-demo* ( display mm ) )
    ( setf new-i ( new-individual ( + 1 ( size np ) ) ( individual-rbg-string mm
) ) )
    ( setf
        ( population-individuals np )
        ( append ( population-individuals np ) ( list new-i ) )
    )
    nil
)

( defmethod empty-population ( ( cp population ) &aux np )
    ( setf np ( make-instance 'population ) )
    ( setf ( population-individuals np ) () )
    ( setf ( population-generation np ) ( + 1 ( population-generation cp ) ) )
    np
)
```

```
( defmethod perform-copies-demo ( &aux cp np )
( setf cp ( initial-population ) )
( setf np ( empty-population cp ) )
( format t "----------------------------------------------------------------------")
( display np )
( format t "~%~%----------------------------------------------------------------------")
( setf *select-demo* t )
( setf *copy-demo* t )
( dotimes ( i 10 )
( perform-one-copy cp np )
( format t "----------------------------------------------------------------------")
( display np )
( format t "~%~%----------------------------------------------------------------------")
)
( setf *select-demo* nil )
( setf *copy-demo* nil )
nil
)
```

Task 10: Crossover

Task 10 Demo:

[1]> (load "rbg.l")

;; Loading file rbg.l ...

;; Loaded file rbg.l

T

[2]> (perform-crossovers-demo)

Generation 1 population ...

---the sample of individuals ...

62 (B B G R R R B B G G G R R G G R B B R G R B R G R) 7

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

6 (G G R B G G R B R R B G R B G R B R R G R R B B G) 7

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

50 (G R B B R R B B G R B R R G B R G R R G B R G R G) 7

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

75 (G B G B R G G G R B R G R R R R B G G B B G G R B) 7

84 (B B B G B R B R R B G B G R R G G R G B B B R R R) 10

the most fit of the sample ...

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

the sample of individuals ...

27 (R R R B G G B G B G R G B G R G G G B G G R G R B) 6

47 (G R G B R B G B G R R R G R B G G G R R R B R B R) 6

29 (R G R R R R R B R R G R B B G R R G R G B B G B G) 6

68 (R G G R R R R R B R G B B B R B R B G R G R R B B) 8

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

39 (G B G B G R R G R R B B G R R G B G B G R G B R G) 7

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

the most fit of the sample ...

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

Selected mother =

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

Selected father =

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

the crossover =

0 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

the possibly mutated individual =

0 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

the renumbered individual =

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

----------the sample of individuals ...

89 (G G B G R G R R G R G G G G B R G B R B R B B B B) 8

21 (R G B R B G R B G R G G G B B G B G R B R R R R R) 7

85 (B R G B G B G B R B G B B G B G G G B R B G B R G B) 12

81 (B R R G B R R G B R B R R G B B R G G R G G G G B) 7

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

5 (G R B G G R B B R B R B R R G R R R G B B B B R G) 9

17 (B G R B R G R R R R B B R G R G G G R R B R B B G) 7

57 (R G G R G R R B G G G R B R B G R G R B R B R B R) 6

the most fit of the sample ...

85 (B R G B G B G B R B G B B G B G G G B R B G B R G B) 12

the sample of individuals ...

73 (G G B R G B G B G B R R R G R R B B G B B G R G G) 8

23 (G B G B R R R R G B G B B R G B G R B G B R G R B) 9

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

4 (G R G B R G R G R G G R G B G G B G B R R R R G G) 4

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

95 (G B R G G R G G R G R B G R B G G G B G R R G G B B) 6

28 (B G G G R R R B G B G G R B B G B G B G B G R B G R B) 9

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

the most fit of the sample ...

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

Selected mother =

85 (B R G B G B G B R B G B B G B G G B R B G B R G B) 12

Selected father =

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

the crossover =

0 (B R G B G B G B R R B B G B B B G G B R G B B G R) 12

the possibly mutated individual =

0 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

the renumbered individual =

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

----------the sample of individuals ...

4 (G R G B R G R G R G G R G B G G B G B R R R R G G) 4

31 (B R G B B B G R B G B R R R G B R G R B B R R B G) 10

32 (B R G R B R R R G R G G B R B R R R G R R B B G B) 7

7 (R G R G G B R G B B G G G G B B G B B G G G R R G) 7

40 (B G B B B R G B B B B G B R B R B G G G R B R R R) 12

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

36 (G G B B R R B R G G R R R G R G R R G G G R R G B) 4

the most fit of the sample ...

40 (B G B B B R G B B B B G B R B R B G G G R B R R R) 12

the sample of individuals ...

85 (B R G B G B G B R B G B B G B G G B R B G B R G B) 12

76 (R B G G R G B R G B G G R R G B G B G G R R G B R) 6

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

23 (G B G B R R R R G B G B B R G B G R B G B R G R B) 9

32 (B R G R B R R R G R G G B R B R R R G R R B B G B) 7

77 (G G R B G B R G B R R R G G G G G R R G G B R G R) 4

38 (G G R B R R R G G B B B G G R G B R G G B B R G B) 8

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

the most fit of the sample ...

85 (B R G B G B G B R B G B B G B G G B R B G B R G B) 12

Selected mother =

40 (B G B B B R G B B B B G B R B R B G G G R B R R R) 12

Selected father =

85 (B R G B G B G B R B G B B G B G G B R B G B R G B) 12

the crossover =

0 (B G B B B R G B B B B G B R B R B G G G G B R G B) 13

the possibly mutated individual =

0 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

the renumbered individual =

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

----------the sample of individuals ...

99 (R B R G B B B R G B G B G R R R G G G R G R B G R) 7

27 (R R R B G G B G B G R G B G R G G G B G G R G R B) 6

68 (R G G R R R R R B R G B B B R B R B G R G R R B B) 8

97 (G B B G R G G R G B R G R B G R R G G R G R G B G) 5

30 (G B G G G G B R G B G G B R G G R B B G G B B G B) 9

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

10 (B R R G R R R R G R G B R R B B R R R B B B R B R) 8

the most fit of the sample ...

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

the sample of individuals ...

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

17 (B G R B R G R R R R B B R G R G G G R R B R B B G) 7

79 (B R G G B B B B B B R R R B R G G B B G G R G G G) 10

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

80 (B R R R R G B R B R G B G B B G G G B R G R B G B) 9

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

the most fit of the sample ...

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

Selected mother =

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

Selected father =

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

the crossover =

0 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

the possibly mutated individual =

0 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

the renumbered individual =

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

----------the sample of individuals ...

59 (R B G G R R G R B G B B G R R G B B R R G B B R R) 8

31 (B R G B B B G R B G B R R R G B R G R B B R R B G) 10

24 (G B R B G R G G G G B R B R B R G B G G B G B R R) 8

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

4 (G R G B R G R G R G G R G B G G B G B R R R R G G) 4

15 (G B B G B G B G R R G R R G B R B R G R B B G R R) 8

23 (G B G B R R R R G B G B B R G B G R B G B R G R B) 9

52 (G B R B B B B R B R R G G G R B B R R R G B R R R) 9

the most fit of the sample ...

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

the sample of individuals ...

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

15 (G B B G B G B G R R G R R G B R B R G R B B G R R) 8

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

49 (R R R G G R B B R G G B G G G B R B B G R R G G G) 6

9 (R G R B B G B R G G R G B R R G G B B R G B R B B) 9

9 (R G R B B G B R G G R G B R R G G B B R G B R B B) 9

97 (G B B G R G G R G B R G R B G R R G G R G R G B G) 5

the most fit of the sample ...

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

Selected mother =

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

Selected father =

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

the crossover =

0 (B G R B R G B B B B G B G R B R B R B B B R B G B) 14

the possibly mutated individual =

0 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

the renumbered individual =

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B)

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

---the sample of individuals ...

81 (B R R G B R R G B R B R R G B B R G G R G G G G B) 7

34 (B B G G R B B R R B B B R R B R G G B G R R G R B) 10

35 (G G B R B R R B G B G B R R G B R B G B G R R R G) 8

89 (G G B G R G R R G R G G G G B R G B R B R B B B B) 8

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

the most fit of the sample ...

34 (B B G G R B B R R B B B R R B R G G B G R R G R B) 10

the sample of individuals ...

62 (B B G R R R B B G G G R R G G R B B R G R B R G R) 7

83 (B B B B G G B G G G B B R R R R G R R R R G G B G) 8

81 (B R R G B R R G B R B R R G B B R G G R G G G G B) 7

55 (G R G R R R B G R R R G G G R B R B G R B B B G G) 6

22 (R B G B R G G B R B G B G G G G G G B R R B B G G) 8

25 (R B G R B B R R B B G G G R G R B R G G B R B R R) 8

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

93 (G R G G B R B G R R R B R R R G G B B G G B R R R) 6

the most fit of the sample ...

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

Selected mother =

34 (B B G G R B B R R B B B R R B R G G B G R R G R B) 10

Selected father =

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

the crossover =

0 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

the possibly mutated individual =

0 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

the renumbered individual =

6 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

6 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

----------the sample of individuals ...

17 (B G R B R G R R R R B B R G R G G G R R B R B B G) 7

44 (B R G R G R R G B G G R B B G R G B R R G G R B G) 6

63 (G G R G R G G G R B R B G R G B G R B R R G B B B) 7

47 (G R G B R B G B G R R R G R B G G G R R R B R B R) 6

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

51 (R R G R R G B G G R R G B B G R G G R B B B B B R) 8

30 (G B G G G G B R G B G G B R G G R B B G G B B G B) 9

25 (R B G R B B R R B B G G G R G R B R G G B R B R R) 8

the most fit of the sample ...

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

the sample of individuals ...

58 (B B B B B B R R G G R G B B R G B G B R G G G B B) 12

10 (B R R G R R R R G R G B R R B B R R R B B B R B R) 8

20 (R R B R B B B R B B B G R R G G G B B G G B G G G B) 10

74 (G R B B B R G G R R G G R G R G B R R G G B G B G) 6

31 (B R G B B B G R B G B R R R G B R G R B B R R B G) 10

83 (B B B B G G B G G G B B R R R R G R R R R G G B G) 8

6 (G G R B G G R B R R B G R B G R B R R G R R B B G) 7

69 (G B B B B R B G G G B G G G R B G G G G R G G G B) 8

the most fit of the sample ...

58 (B B B B B B B R R G G R G B B R G B G B R G G G B B) 12

Selected mother =

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

Selected father =

58 (B B B B B B B R R G G R G B B R G B G B R G G G B B) 12

the crossover =

0 (R B G B B R B B G G R G B B R G B G B R G G G B B) 11

the possibly mutated individual =

0 (R B G B B G B B G G R G B B R G B G B R G G G B B) 11

the renumbered individual =

7 (R B G B B G B B G G R G B B R G B G B R G G G B B) 11

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

6 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

7 (R B G B B G B B G G R G B B R G B G B R G G G B B) 11

----------the sample of individuals ...

27 (R R R B G G B G B G R G B G R G G G B G G R G R B) 6

16 (G B G B B G R G R G R G B G R B R G G G B R G B B) 8

98 (R R R B R R B B R G B R R B B B G B G B B G B B B) 13

24 (G B R B G R G G G G B R B R B R G B G G B G B R R) 8

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

35 (G G B R B R R B G B G B R R G B R B G B G R R R G) 8

97 (G B B G R G G R G B R G R B G R R G G R G R G B G) 5

the most fit of the sample ...

98 (R R R B R R B B R G B R R B B B G B G B B G B B B) 13

the sample of individuals ...

3 (R B B G B G B G R B G B B B G B R R G B B G B B B) 14

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

84 (B B B G B R B R R B G B G R R G G R G B B B R R R) 10

57 (R G G R G R R B G G G R B R B G R G R B R B R B R) 6

2 (G B B R G B G B B R G R R R G R R G G B G G B G R) 7

61 (B G B R R B G G R R B R G R G R R B G B R B G G G) 7

12 (R R R R B B R B G R R G R R R G R R B R G G R B B) 6

97 (G B B G R G G R G B R G R B G R R G G R G R G B G) 5

the most fit of the sample ...

3 (R B B G B G B G R B G B B B G B R R G B B G B B B) 14

Selected mother =

98 (R R R B R R B B R G B R R B B B G B G B B G B B B) 13

Selected father =

3 (R B B G B G B G R B G B B B G B R R G B B G B B B) 14

the crossover =

0 (R R R G B G B G R B G B B B G B R R G B B G B B B) 12

the possibly mutated individual =

0 (R R B G B G B G R B G B B B G B R R G B B G B B B) 13

the renumbered individual =

8 (R R B G B G B G R B G B B B G B R R G B B G B B B) 13

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

6 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

7 (R B G B B G B B G G R G B B R G B G B R G G G B B) 11

8 (R R B G B G B G R B G B B B G B R R G B B G B B B) 13

----------the sample of individuals ...

19 (B B B G G B R G G R B G R R G G G B G B B G R B G) 9

56 (G R R R B B G B G G R R G R B R R R B R B B R G R) 7

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

29 (R G R R R R R B R R G R B B G R R G R G B B G B G) 6

91 (R G R B B B B G G R B B G R G G B G G B G B G R R) 9

15 (G B B G B G B G R R G R R G B R B R G R B B G R R) 8

30 (G B G G G G B R G B G G B R G G R B B G G B B G B) 9

53 (B G R G R B G R B G R R B R R B G R G B R G G B R) 7

the most fit of the sample ...

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

the sample of individuals ...

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

6 (G G R B G G R B R R B G R B G R B R R G R R B B G) 7

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

55 (G R G R R R B G R R R G G G R B R B G R B B B G G) 6

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

55 (G R G R R R B G R R R G G G R B R B G R B B B G G) 6

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

the most fit of the sample ...

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

Selected mother =

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

Selected father =

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

the crossover =

0 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

the possibly mutated individual =

0 (R R R R B R G R R R B B B G B B R G B B R G G R G) 8

the renumbered individual =

9 (R R R R B R G R R R B B B G B B R G B B R G G R G) 8

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

6 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

7 (R B G B B G B B G G R G B B R G B G B R G G G B B) 11

8 (R R B G B G B G R B G B B B G B R R G B B G B B B) 13

9 (R R R R B R G R R R B B B G B B R G B B R G G R G) 8

---the sample of individuals ...

26 (G G G G R R B B G R B B B G G G G R B G R G G G B) 7

77 (G G R B G B R G B R R R G G G G G R R G G B R G R) 4

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

21 (R G B R B G R B G R G G G B B G B G R B R R R R R) 7

70 (G R R G B B B G G B B R R B G R G B B B B G G B G) 11

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

the most fit of the sample ...

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

the sample of individuals ...

55 (G R G R R R B G R R R G G G R B R B G R B B B G G) 6

44 (B R G R G R R G B G G R B B G R G B R R G G R B G) 6

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

91 (R G R B B B B G G R B B G R G G B G G B G B G R R) 9

73 (G G B R G B G B G B R R R G R R B B G B B G R G G) 8

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

99 (R B R G B B B R G B G B G R R R G G G R G R B G R) 7

50 (G R B B R R B B G R B R R G B R G R R G B R G R G) 7

the most fit of the sample ...

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

Selected mother =

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

Selected father =

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

the crossover =

0 (B B G B B B B R G G G R B B B G R G R B R B G G G) 11

the possibly mutated individual =

0 (B B G B B B B R G G G R B B B G R G R B R B G G G) 11

the renumbered individual =

10 (B B G B B B B R G G G R B B B G R G R B R B G G G) 11

Generation 1 population ...

1 (G B G B B B B R G G G R B B B G R G B G B B R G B) 12

2 (B R G B G B G B R G B B G B B B G G B R G B B G R) 12

3 (B G B B B R G B B B B B B B R B R B G G G G B R G B) 14

4 (B B B G R R G B B G B R R G G R G R G B R B B R B) 10

5 (B G R B R G B B G B G B G R B R B R B B B R B G B) 13

6 (B B G B G R G G B G G B G R B R B R B B B R B G B) 12

7 (R B G B B G B B G G R G B B R G B G B R G G G B B) 11

8 (R R B G B G B G R B G B B B G B R R G B B G B B B) 13

9 (R R R R B R G R R R B B B G B B R G B B R G G R G) 8

10 (B B G B B B B R G G G R B B B G R G R B R B G G G) 11

Task 10 Code:

```
;-------------------------------------------------------------
; Task 10: Crossover

( setf *crossover-demo* nil )

( defconstant *pc-x* 60 )

( defmethod perform-crossovers ( ( cp population ) ( np population ) )
    ( dotimes ( i ( nr-crossovers ) )
        ( perform-one-crossover cp np )
    )
)

( defmethod nr-crossovers ()
    ( * ( / *pc-x* 100 ) *population-size* )
)

( defmethod perform-one-crossover ( ( cp population ) ( np population ) )
    ( let ( x m mm mother father new-i )
        ( setf mother ( select-individual cp ) )
        ( setf father ( select-individual cp ) )
        ( if *crossover-demo* ( format t "Selected mother = ~%" ) )
        ( if *crossover-demo* ( display mother ) )
        ( if *crossover-demo* ( format t "Selected father = ~&" ) )
        ( if *crossover-demo* ( display father ) )
        ( setf m ( crossover mother father ) )
        ( if *crossover-demo* ( format t "the crossover = ~&" ) )
        ( if *crossover-demo* ( display m ) )
        ( setf mm ( maybe-mutate m ) )
        ( if *crossover-demo* ( format t "the possibly mutated individual = ~&" )
)
        ( if *crossover-demo* ( display mm ) )
        ( setf ( individual-number mm ) ( + 1 ( size np ) ) )
        ( if *crossover-demo* ( format t "the renumbered individual = ~&" ) )
        ( if *crossover-demo* ( display mm ) )
        ( setf new-i ( new-individual ( + 1 ( size np ) ) ( individual-rbg-string
mm ) ) )
        ( setf
            ( population-individuals np )
            ( append ( population-individuals np ) ( list new-i ) )
        )
    )
    nil
```

```
)

( defmethod crossover ( ( mother individual ) ( father individual )
    &aux mi fi x i )
    ( setf mi ( individual-rbg-string mother ) )
    ( setf fi ( individual-rbg-string father ) )
    ( setf x ( crossover mi fi ) )
    ( setf i ( new-individual 0 x ) )
    i
)

( defmethod perform-crossovers-demo ( &aux cp np )
    ( setf cp ( initial-population ) )
    ( setf np ( empty-population cp ) )
    ( format t "------------------------------------------------------------------
-")
    ( display np )( format t "~%~%-----------------------------------------------
---------------")
    ( setf *select-demo* t )
    ( setf *crossover-demo* t )
    ( dotimes ( i 10 )
        ( perform-one-crossover cp np )
        ( format t "------------------------------------------------------------
----")
        ( display np )
        ( format t "~%~%-----------------------------------------------------------
----")
    )
    ( setf *select-demo* nil )
    ( setf *crossover-demo* nil )
    nil
)
```

Task 11: The GA

Task 11 Demo:

[2]> (ga)

THE WORLD IS BLUE

Generation 0 population ...

1 (G R R G R G G B R B R B B B G R G G B R R R G B R) 7

2 (G B B R G B G B B R G R R R G R R G G B G G B G R) 7

3 (R B B G B G B G R B G B B B G B R R G B B G B B B) 14

4 (G R G B R G R G R G G R G B G G B G B R R R R G G) 4

5 (G R B G G R B B R B R B R R G R R R G B B B B R G) 9

6 (G G R B G G R B R R B G R B G R B R R G R R B B G) 7

7 (R G R G G B R G B B G G G G B B G B B G G G R R G) 7

8 (G G G R R R R R R R G G R G G B G B G B B R R R R) 4

9 (R G R B B G B R G G R G B R R G G B B R G B R B B) 9

10 (B R R G R R R R G R G B R R B B R R R B B B R B R) 8

11 (R R G G G B G R G G B R G R B G G R B R B B R G G) 6

12 (R R R R B B R B G R R G R R R G R R B R G G R B B) 6

13 (B G R B R G B B B B B B R G R R G G G B B G R B R) 11

14 (G B R G G R R G G R B B B G R R G R B R R R R B R) 6

15 (G B B G B G B G R R G R R G B R B R G R B B G R R) 8

16 (G B G B B G R G R G R G B G R B R G G G B R G B B) 8

17 (B G R B R G R R R R B B R G R G G G R R B R B B G) 7

18 (R G G B R G R G B G R B R R B R G B G R R G R G R) 5

19 (B B B G G B R G G R B G R R G G G B G B B G R B G) 9

20 (R R B R B B R B B B G R R G G G B B G G B G G G B) 10

21 (R G B R B G R B G R G G G B B G B G R B R R R R R) 7

22 (R B G B R G G B R B G B G G G G G G B R R B B G G) 8

23 (G B G B R R R R G B G B B R G B G R B G B R G R B) 9

24 (G B R B G R G G G G B R B R B R G B G G B G B R R) 8

25 (R B G R B B R R B B G G G R G R B R G G B R B R R) 8

26 (G G G G R R B B G R B B B G G G G R B G R G G G B) 7

27 (R R R B G G B G B G R G B G R G G G B G G R G R B) 6

28 (B G G G R R R B G B G G R B B G B G B G R B G R B) 9

29 (R G R R R R R B R R G R B B G R R G R G B B G B G) 6

30 (G B G G G G G B R G B G G G B R G G G R B B G G B B G B) 9

31 (B R G B B B B G R B G B R R R G B R G R B B B R R B G) 10

32 (B R G R B R R R G R G G B R B R R R G R R B B G B) 7

33 (G G G G R G B G B B R G G G G R R G R B R R G R R) 4

34 (B B G G R B B R R B B B R R B R G G B G R R G R B) 10

35 (G G B R B R R B G B G B R R G B R B G B G R R R G) 8

36 (G G B B R R B R G G R R R G R G R R G G G R R G B) 4

37 (B R R B G G R G R B R R G R B R R B R R R B G R B) 7

38 (G G R B R R R G G B B B G G R G B R G G B B R G B) 8

39 (G B G B G R R G R R B B G R R G B G B G R G B R G) 7

40 (B G B B B R G B B B B G B R B R B G G G R B R R R) 12

41 (R G R B G R G G B G G B G R B R B R B B B R B G B) 10

42 (B R G B R G B B G G G G B G R G G G G B G R B G G) 7

43 (B B B B B G R B B R G B G G G G G B G R G R G G G) 9

44 (B R G R G R R G B G G R B B G R G B R R G G R B G) 6

45 (B B B G R R G B B B R R B R B G G R B G B B R G B) 12

46 (G G R B B R B B R B G G B R B B B B R B G R G R B) 12

47 (G R G B R B G B G R R R G R B G G G R R R B R B R) 6

48 (B B B G G R B B G R R G G B R G R G B R B B B B G) 11

49 (R R R G G R B B R G G B G G G B R B B G R R G G G) 6

50 (G R B B R R B B G R B R R G B R G R R G B R G R G) 7

51 (R R G R R G B G G R R G B B G R G G R B B B B B R) 8

52 (G B R B B B B B R B R R G G G R B B R R R G B R R R) 9

53 (B G R G R B G R B G R R B R R B G R G B R G G B R) 7

54 (R R R G B R G R R R B B B G B B R G B B R G G R G) 8

55 (G R G R R R B G R R R G G G R B R B G R B B B G G) 6

56 (G R R R B B G B G G R R G R B R R R B R B B R G R) 7

57 (R G G R G R R B G G G R B R B G R G R B R B R B R) 6

58 (B B B B B B R R G G R G B B R G B G B R G G G B B) 12

59 (R B G G R R G R B G B B G R R G B B R R G B B R R) 8

60 (R B G B B R B B G G R R G B B G R R G B G G R B G) 9

61 (B G B R R B G G R R B R G R G R R B G B R B G G G) 7

62 (B B G R R R B B G G G R R G G R B B R G R B R G R) 7

63 (G G R G R G G G R B R B G R G B G R B R R G B B B) 7

64 (G G G G G B B R R G G G G B R B B B R R G G G G R R) 5

65 (B B R B R B G R R R B B G B B B G G B R G B B G R) 12

66 (R R B R B G B R B G G R G B B R B G B R B G B R G) 10

67 (R B R G B B G B G G B G G B R G R G B R G B B B B) 11

68 (R G G R R R R R B R G B B B R B R B G R G R R B B) 8

69 (G B B B B R B G G G B G G G R B G G G G R G G G B) 8

70 (G R R G B B B G G B B R R B G R G B B B B G G B G) 11

71 (B G G R G R B G B G R G R R B B G G B B B G B B G) 10

72 (B G B G R B B G G R G R G R G B R G B B B G G B B) 10

73 (G G B R G B G B G B R R R G R R B B G B B G R G G) 8

74 (G R B B B R G G R R G G R G R G B R R G G B G B G) 6

75 (G B G B R G G G R B R G R R R R B G G B B G G R B) 7

76 (R B G G R G B R G B G G R R G B G B G G R R G B R) 6

77 (G G R B G B R G B R R R G G G G G R R G G B R G R) 4

78 (R G G R G G B R R B R B R R G B B B R R R G R R B) 7

79 (B R G G B B B B B B R R R B R G G B B G G R G G G) 10

80 (B R R R R G B R B R G B G B B G G G B R G R B G B) 9

81 (B R R G B R R G B R B R R G B B R G G R G G G G B) 7

82 (B B G R B B G R R B R R R R R R G B R G R G G B R) 7

83 (B B B B G G B G G G B B R R R R G R R R R G G B G) 8

84 (B B B G B R B R R B G B G R R G G R G B B B R R R) 10

85 (B R G B G B G B R B G B B G B G G G B R B G B R G B) 12

86 (B G R G R B R G B G R G B B R R B G R G R B R R R) 7

87 (B R G R B R B R R G G R R B R B R G G B R B B R B) 9

88 (B B B R B G R G R R G G G R B B B G R R R R R G G) 7

89 (G G B G R G R R G R G G G G B R G B R B R B B B B) 8

90 (G G R B R G B G B G R G R B B B B B G B G R B G G) 10

91 (R G R B B B B G G R B B G R G G B G G B G B G R R) 9

92 (B B R G B G B B B G B R R G G R G R G B R B B R B) 11

93 (G R G G B R B G R R R B R R R G G B B G G B R R R) 6

94 (G B G B B B B R G G G R B B B G R G R B R B G G G) 10

95 (G B R G G R G G R G R B G R B G G B G R R G G B B) 6

96 (G G G B G B R R B B B G G R R B G B R R R B R R R) 8

97 (G B B G R G G R G B R G R B G R R G G R G R G B G) 5

98 (R R R B R R B B R G B R R B B B G B G B B G B B B) 13

99 (R B R G B B B R G B G B G R R R G G G R G R B G R) 7

100 (R B B G G R G B B R B R G G B G R G G G G G R G G) 6

average fitness of populatioon 0 = 8.01

average fitness of populatioon 1 = 10.85

average fitness of populatioon 2 = 12.99

average fitness of populatioon 3 = 15.06

average fitness of populatioon 4 = 16.67

average fitness of populatioon 5 = 17.99

average fitness of populatioon 6 = 19.03

average fitness of populatioon 7 = 19.91

average fitness of populatioon 8 = 20.77

average fitness of populatioon 9 = 21.72

average fitness of populatioon 10 = 22.49

average fitness of populatioon 11 = 23.19

average fitness of populatioon 12 = 23.69

average fitness of populatioon 13 = 23.98

average fitness of populatioon 14 = 24.39

average fitness of populatioon 15 = 24.44

average fitness of populatioon 16 = 24.5

average fitness of populatioon 17 = 24.54

average fitness of populatioon 18 = 24.57

average fitness of populatioon 19 = 24.51

average fitness of populatioon 20 = 24.49

average fitness of populatioon 21 = 24.5

average fitness of populatioon 22 = 24.45

average fitness of populatioon 23 = 24.53

average fitness of populatioon 24 = 24.44

average fitness of populatioon 25 = 24.42

Generation 25 population ...

1 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
2 (B B B B B B B B B B B B B B B B B B B B B R B B B) 24
3 (B B B B B B B B B B B B B B B B B B B B B G B B B B) 24
4 (B B B B B B B B B B B B B R B B B B B B B B B B B) 24
5 (B B B B B B B B B B B B B B B B B B B G B B B B B B) 24
6 (B B B B B B B G B B B B B B B B B B B B B B B B B) 24
7 (B B R B B B B B B B B B B B B B B B B B B B B B B) 24
8 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
9 (B B B B B B B B B B B B G B B B B B B B B B B B B) 24
10 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
11 (B B B B B B B B B G B B B B B B B B B B B B B B B) 24
12 (B B B B B G B B B B B B B B B B B B B B B B B B B) 24
13 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
14 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
15 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
16 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
17 (B B B B B B B B B B B B B B B G B B B B B B B B) 24
18 (B B B B B B B B B B B B B B B B B B B B B B B B R) 24
19 (B B B B B B B B B B B B B B B B B B B G B B B B) 24
20 (B B B B B B B B B B R B B B B B B B B B B B B B) 24
21 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
22 (B B R B B B B B B B B B B B B B B B B B B B B B B) 24
23 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
24 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25
25 (B B B B B B B B B B B B B B B B B G B B B B B B B) 24
26 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

27 (B B B B B B B B B B B B B B B B B B B G B B R B B) 23

28 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

29 (B B B B B B B B B B B B B B B B B B B G B B B B) 24

30 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

31 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

32 (B B B B B B B B B R B B B B B B B B B B B B B B) 24

33 (B B B B B B B B B B B B B B B B B B B B B R B B) 24

34 (B B B B B B B B B B B B B B B B B B B B B B R B) 24

35 (B B B B B B B B B G B B B B B B B B B B B B B) 24

36 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

37 (B B B G B B B B B B B B B B B B B B B B B B B B) 24

38 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

39 (B R B B B B B B B B B B B B B B B B B B B B B B) 24

40 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

41 (B B B B B B B B B B B B B B B B B B B B B R B B) 24

42 (B B B B R B B B B B B B B B B B B B B B B B B B) 24

43 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

44 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

45 (B B B G B B B B B B B B B R B B B B B B B B B) 23

46 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

47 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

48 (B B B B B B B B B G B B B B B B B B B B B B B) 24

49 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

50 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

51 (B B B B B B B B B B B B B B B B B B B B B B B R) 24

52 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

53 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

54 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

55 (B B B B B B R B B B B B B B B B B B B B B B B B B) 24

56 (B B B B B B B G B B B B B B B B B B B B B B B B B) 24

57 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

58 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

59 (B B B B B R B B B B B B B B B B B B B B B B B B B) 24

60 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

61 (B B B B B B B R B B B B B B B B B B B B B B B B B) 24

62 (G B B B B B B B B B B B B B B B B B B B B B B B B) 24

63 (B B B B B B B B B B B B B B B B G B B B B B B) 24

64 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

65 (B B B B B B B B B B B B B B B B B B B G B B B B) 24

66 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

67 (B B B B B B B B B B R B B B B B B B B B B B B B B) 24

68 (B B B B B B B B B B B B B B B B B R B B B B B B) 24

69 (B B B B B B B B B G B B B B B B B B B B B B B B) 24

70 (B B B B B B B B B B B B B B B B B B R B B B B B) 24

71 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

72 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

73 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

74 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

75 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

76 (G B B B B B B B B B B B B B B B B B B B B B B B B) 24

77 (B B B B B B B B B B B B B B B B B B B B B R B B B) 24

78 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

79 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

80 (B B B B B B B G B B B B B B B B B B B B B B B B) 24

81 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

82 (B B B R B B B B B B B B B B B B B B B B B B B B B) 24

83 (B B B B B B B B B B B B B B B B B B B R B B B B) 24

84 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

85 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

86 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

87 (B B B B B B R B B B B B B B B B B B B B B B B B B) 24

88 (B B B B B B B B B B B B B B B B B B B B B B B B R) 24

89 (G B B B B B B B B B B B B B B B B B B B B B B B B) 24

90 (B B B B B G B B B B B B B B B B B B B B B B B B B) 24

91 (B B B B B B B B G B B B B B B B B B B B B B B B B) 24

92 (B B B G B B B B B B B B B B B B B B B B B B B B B) 24

93 (B B B B B B B B B B B G B B B B B B B B B B B B B) 24

94 (B B B B B B B B B B R B B B B B B B B B B B B B B) 24

95 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

96 (B B B B B B B B B B B B B B B B B B B B B B B B B) 25

97 (B B B B B B B B B B B G B B B B B B B B B B B B B) 24

98 (B B B B B B B B B B B B B B G B B B B B B B B B B) 24

99 (B B B B B B B B B B B B B B B B B B B R B B B B B) 24

100 (B B B B B B B B B B B B B B B B B B B B B B B B G) 24

average fitness of populatioon 25 = 24.42

THE WORLD IS RED

Generation 0 population ...

1 (B R B R B G B R B B R B R R R G G R B R R G R B G) 11

2 (R B B R G B R B B G R B G B R R R G B B B G R B R) 9

3 (R B R R G G R B G G G G G B G R R R B R G B R G B) 9

4 (R B G R R R B R G G R G R B G B G G G B R B G R R) 10

5 (B G B R B G B B G B R R G G R G G G G G R R R G R) 8

6 (B B R B B G R B R R R B R R G G G R G B G R G G R) 10

7 (B R B G R R B B R G R R R B G R R R G G G B R B R) 12

8 (R B R B B B R G G G R R R G R G G G R G B R B B B) 9

9 (B G B B R G G R R B B R G B G B G R G R R B R B B) 8

10 (B G R B G R G B B R B G B R B R R R G R B B B R R) 10

11 (G G G G G R R G R R R G G G G B R G G B B R G B G) 7

12 (G B B R R G B G R G B R B B B G G G B R B B G G R) 6

13 (R G G R G G G R G R B G G R R G G R G B B R B G G) 8

14 (R G G G R B B B G R G R G B B B B R G G B R B G G) 6

15 (R B G B B R B R B G B R B B B R R B G G G R B R G) 8

16 (G G B B B G G B R B B B B B R G G R B R R R B G B) 6

17 (R R G R R G R R B R B G G G B R B G R B R B G B B) 10

18 (R B G B R B R B B G G B B G G B R G B G G B G G B) 4

19 (R B B B R R R B B G G B G R R R R B B R G R R R B) 12

20 (G B G G G B G G G B R B B B B G G R G G G R R G B) 4

21 (R R B B B G R B R R R G R G B R B B B B R G R B G G) 10

22 (B B G B G G G R R B B B R G R B R G G G R B R G R R) 9

23 (B B B G R B R G G B R B R B B R G R B R G B B G G) 7

24 (B B G B B G G B B G B R G G R R R G B R R G B B B) 6

25 (B B R B R G R R B G G R B R R B R R G R G R R B G) 12

26 (B G G B G G R R R R B G R G G B B B R B R B B B R) 8

27 (R G G G R R R R R R R B B R G B R B G G R R G G B) 12

28 (G G B B R G G B R B R R R G R G B B G B R R G B R) 9

29 (R R R G B R G R R R R B R R G B G R R R B R R R B) 16

30 (R R R R G R G R R R R B R R B B B G B R B R G G G) 13

31 (G G R R G B B G G G B G R R G R R G R B R R R B R) 11

32 (G R B G R R G R G B R G R B G R B R B B G G G B B) 8

33 (R R R G R G B B B G R G G G G G G G R B G B R G B) 7

34 (R G G G G G G G G B G B R R B R G G B B G B B R G) 5

35 (G B B G G R R B B G R G R G B G G R R R G B R R B) 9

36 (B G R R G G G G G B R G G B B R R G B G B G G B B) 5

37 (B G B R R B R R R R B B B G R G R B R R R R B G B) 12

38 (R B R R B R G B B G R B B B B B B B R B B B B G G) 6

39 (B R G G G R G G B B R R B R R G R B G B G G R G B) 8

40 (G B R G G G B R B B B B R B G B G R R R B G B R B R) 8

41 (R G R B G R G G B G R G R R G R G G B G B R B R B) 9

42 (B R B G R G G G G R B G B R G G B G G G R G G G R) 6

43 (G R B R B B G B R B G B B R R G G G G B B R R B R) 8

44 (B B B B G R G B G R B G G G R R B G G B G G B G R) 5

45 (G B R G B G R B G G B R R B G B R R B R R R B B G) 9

46 (G G B B G R R R R G B B G G R R G B B R B B B B R) 8

47 (R R B B B G R G R G G G R G G B B B G G R B R R R) 9

48 (R R G R R G G B B G B R R B B B R B R R R G G R B) 11

49 (R B R G G G G B B G R R R R R B B B B R R B R G R) 11

50 (G G R G G B R R R R G G R G G B G R G R G R B R R) 11

51 (R G R B G R R R R B G G B R G B G R G R R B G B B) 10

52 (G G B G G G R G G R G R B B R R B G B B R B B G G) 6

53 (B G R B B R R B R R G R G R G B G B R G G R B B B) 9

54 (G B R B G R R G B R R B B R G R R G G B R B G G R) 10

55 (G R R G G B R G G B B G R G G R B G G R B B B B R) 7

56 (G G B G R B R B R B G G R B B R R B B R R G B R R) 10

57 (B B B B B G B B R G G G R G G G B R R B B G G R R) 6

58 (R R B B G G R B G R G B B G B B B B G R G G R B G) 6

59 (R R G B B G R R R B B R B G R G R R B R B R R G B) 12

60 (G R G B G R R R B R R B R R R G G B G R R R G R B) 13

61 (R B G G B G G G G R G B G B B G R R G R G R G G G) 6

62 (G G G B R R G B B B R B R B R G B B R G B B B B B) 6

63 (B G R B B B R B R R R R G B R G R R R B B B B G G) 10

64 (R G B B R G G R B B G R B B G B B G R G B R R B R) 8

65 (R R R G R R B G B B R B R R B G G B B B B R G G B) 9

66 (G R G B R B R G B G G G B G B G B G G R R G R R G) 7

67 (B R G G G G R R G B B B R R B G G B B B B R B B B) 6

68 (R G R R B G R B B B R R B G R R R B G B R R G B B) 11

69 (R B G G R R G B B G B G G B G R G G R G R B G B G) 6

70 (R R R G G R G G G R B R B G B B G B G R G B G R R) 9

71 (B B R G G B R G B R G G R B B R G G G B G G G G R) 6

72 (G G R G R B B R B B R B G R B R R G G R G B G G R) 9

73 (G G R G R G B G R R B G G R B B G G G R R R G B G) 8

74 (G R G G B B B B R R G R R G G R G G B R G R R B G) 9

75 (B R R B R G G G R G G B R G G R G G G R G G B R R) 9

76 (G G B G B G R G B G B B G B B R B R B R B G G G R) 5

77 (B G R B G R G G R R B R B R B G G B R G R R B G R) 10

78 (B R B B G R B B B B R R R G R B G B R B B B B G G) 7

79 (G G R B G G B G R R B B R B G G R R B G G B G G B) 6

80 (R B B B R B R R G R R G G B G G G G R G G B G G R) 8

81 (B B G R G B R G B R B B G G B R G R R G G B B R R) 8

82 (R B R G R R G B B G R R R B G R G R G B G R G B G) 10

83 (G R G B G R B R R B R G R B G R G B B G G B R B R) 9

84 (B B R R G G B R G G G R B R R B G B G R R B B B B) 8

85 (B B B G G R B R G B R G B B B G R G R R G R B R R) 9

86 (R B R B B R B G R B B R B R B B G B G B B R G B R) 8

87 (R B R R G G B B B G B B G B G G B R G B B R B R R) 7

88 (B B G R R G R B R G R R R B G R G B G B B G R R R) 11

89 (R G B R R R R G G R B G R B R B G B R G G R B B B) 10

90 (R B R B G R R R R B R R B G R R B G B B R G R R R) 14

91 (G G G B B B B R R G R R G G G G B B R B B G B R R) 7

92 (R G B R R B R B B G B G G G B R R B B B B G B B G) 6

93 (R B B G G G G R R R R R G B G R B R R R B B G R B) 11

94 (R R B B R B B G R B B B B R G B G R B R R R B G B) 9

95 (G B G G G B G B B G R G G B R R R B R G G R R G G) 7

96 (B R G B R G B G G G R B R G B G G G G G G G G B R B) 5

97 (R G G G B B G B B R G G R R G G G G B B B G B G G) 4

98 (G B G G B B R B R G B R B B B R B B G G R G B G G) 5

99 (G B B R B B B G B B R G R B G B G R R R G G B R R) 8

100 (G R R G G B B G R R R G R B B G B G B G B G B R R) 8

average fitness of populatioon 0 = 8.43

average fitness of populatioon 1 = 11.94

average fitness of populatioon 2 = 14.51

average fitness of populatioon 3 = 16.31

average fitness of populatioon 4 = 17.3

average fitness of populatioon 5 = 18.06

average fitness of populatioon 6 = 18.78

average fitness of populatioon 7 = 19.66

average fitness of populatioon 8 = 20.7

average fitness of populatioon 9 = 21.22

average fitness of populatioon 10 = 21.87

average fitness of populatioon 11 = 22.85

average fitness of populatioon 12 = 23.84

average fitness of populatioon 13 = 24.4

average fitness of populatioon 14 = 24.58

average fitness of populatioon 15 = 24.46

average fitness of populatioon 16 = 24.45

average fitness of populatioon 17 = 24.39

average fitness of populatioon 18 = 24.45

average fitness of populatioon 19 = 24.5

average fitness of populatioon 20 = 24.53

average fitness of populatioon 21 = 24.44

average fitness of populatioon 22 = 24.47

average fitness of populatioon 23 = 24.58

average fitness of populatioon 24 = 24.43

average fitness of populatioon 25 = 24.45

Generation 25 population ...

1 (R R R R R R R G R R R R R R R R R R R R R R R) 24

2 (R R R R R R R R R R R R R R R R R R R R G R R) 24

3 (R R R R R R R R G R R R R R R R R R R R R R R) 24

4 (R R R R R R R R R R R R R R R R R R R R R R R) 25

5 (R R R R B R R R R R R R R R R R R R R R R R R) 24

6 (R R R R R R R R R R R R R R R R R R R R R R R) 25

7 (R R R R R R B R R R R R R R R R R R R R R R R) 24

8 (R R R R R R R R G R R R R R R R R R R R R R R) 24

9 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

10 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

11 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

12 (R R R R R R R R R R R R B R R R R R R R R R R R) 24

13 (R R B R R R R R R R R R R R R R R R R R R R R R) 24

14 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

15 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

16 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

17 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

18 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

19 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

20 (R R R R R R R R R R R R R R R R R G R R R R R) 24

21 (R R R R R R R R R R R R G R R R R R R R R R R R) 24

22 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

23 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

24 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

25 (R R R R R R R R G R R R R R R R R R R R R R R R) 24

26 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

27 (R R R R R R R R R R R R R G R R R R R R R R) 24

28 (R R R R R G R R R R R R R R R R R R R R R R R R) 24

29 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

30 (R R R R R R R R R R R R R R R G R R R R R R) 24

31 (R R R G R R R R R R R R R R R R R R R R R R R R) 24

32 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

33 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

34 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

35 (R R R R R R R R R R R R G R R R R R R R R R R R) 24

36 (R R R R R R R R R R R R R R R R R R R R R R R R R) 25

37 (R R R B R R R R R R R R R R R R R R R R R R R) 24

38 (R R R R R R R R R R R B R R R R R R R R R R R) 24

39 (R R R R R R R R R R R R R R R R R B R R R R) 24

40 (R R R R R R R R R R R R R R R R R B R R R R R) 24

41 (B R R R R R R R R R R R R R R R R R R R R R R) 24

42 (R R R R R R R R R R R R R R R R R R R R R R R) 25

43 (R R R R R R G R R R R R R R R R R R R R R R R) 24

44 (R R R R R R R R R R R R R R R R R R R R R R R) 25

45 (R R R R R R R R R R R R R R R R R R R R R R R) 25

46 (R R R R R R R R R R R R R R R R R R R R R R R) 25

47 (R R R R R R R R R R G R R R R R R R R R R R R) 24

48 (R R R R R R R R R R R R R R R R R R R R R R R) 25

49 (R R R R R R R R R R R R R R R R B R R R R R R) 24

50 (R R R B R R R R R R R R R R R R R R R R R R R) 24

51 (R R R G R R R R R R R R R R R R R R R R R R R) 24

52 (R R R R R R B R R R R R R R R R R R R R R R R) 24

53 (R R R R R R R R R R R R R R R R R R R R R R R) 25

54 (R R R R R R R R R R R R R R R R R R R R B R R R) 24

55 (R R R R R R R R R R R R R R R R R R R G R R R R) 24

56 (R R R R R R R R R R R R G R R R R R R R R R R) 24

57 (R R R B R R R R R R R R R R R R R R R R R R R) 24

58 (R R R R R R R R R R R R R R R G R R R R R R R) 24

59 (R R R R R R R R R R R R R R R R R R R R R R R) 25

60 (R R R R R R G R R R R R R R R R R R R R R R R) 24

61 (R R R R R R R R R R R R R R R R R R R R R R R) 25

62 (R R R R R R R G R R R R R R R R R R R R R R R) 24

63 (R R R R R R R R R R R R R R R R R R R R R R R) 25

64 (R R G R R R R R R R R R R R R R R R R R R R R) 24

65 (R R R R R R R R R R R R R R R R R R R B R R) 24

66 (R R R R R R R R R R R G R R R R R R R R R R) 24

67 (R R R R R R R R R R R R R R R R R R R R R R) 25

68 (R R R R R R G R R R R R R R R R R R R R R R) 24

69 (R R B R R R R R R R R R R R R R R R R R R R) 24

70 (R R R R R R R R R R R R R B R R R R R R R R) 24

71 (R R R R R R R R R R R R R R R R R R R R R R) 25

72 (R R R R R R R R R R R R R R R R R R R R R R) 25

73 (R R R R R R R R R R R R R R R R R R R R R R) 25

74 (R R R R R B R R R R R R R R R R R R R R R R) 24

75 (R R R R R R R R R R R R R R R R R R R R R B) 24

76 (R R R R R R R R R R R R R R R R R R R R R R) 25

77 (R R R R R R R R R R R R R R R R R R R R R R) 25

78 (R R R R R R R R R R R R R R R R R R R R R R) 25

79 (R R R R R R R R R R R R R R R R R R R R R G) 24

80 (R R R R R R R R R R R R R R R R R R R R R R) 25

81 (R R R R R R R R R R R R R R R R R R R R R R) 25

82 (R R R R R R R R R R R R R R B R R R R R R R) 24

83 (R R R R R R R R R R R R R R R R R R R R R R) 25

84 (R R R R R R R R R R R R R R R R R R R R R R) 25

85 (R R R B R R R R R R R R R R R R R R R R R R) 24

86 (R R R R R R R R R R R R R G R R R R R R R R) 24

87 (R R R R R R R R R R R R R R R R R R R R R R) 25

88 (R R R R R R G R R R R R R R R R R R R R R R) 24

89 (R R R R R R R R R R R R R R R R R R R R R R) 25

90 (R R R R R R R R R R R R R R R R R R R R R R) 25

91 (R R R R R R R R R R R R R R R R R R R R R R) 25

92 (R R R R R R R R R R R R G R R R R R R R R R) 24

93 (R R R R R R R R R R R R R R R R R R R B R R R) 24

94 (R R R R R R R R R R R R R R R R R R R R R R R) 25

95 (R R R R R B R R R R R R R R R R R R R R R R R) 24

96 (R R B R R R R R R R R R R R R R R R R R R R R) 24

97 (R R R B R R R R R R R R R R R R R R R R R R R) 24

98 (R R R R R R R R G R R R R R R R R R R R R R R) 24

99 (R R R B R R R R R R R R R R R R R R R R R R R) 24

100 (R R R R R R R R R R R R R R G R R R R R R R R) 24

average fitness of populatioon 25 = 24.45

THE WORLD IS GREEN

Generation 0 population ...

1 (B R G B R G R B R B B B R G G G G B G R B R G B R) 8

2 (G B G B G G G R R B R R B R R B R G B G B R R G R) 8

3 (B B G B G G G R G R B R G G G B B B R R G B G G B G) 11

4 (G G B B G B R R B B R R G B B G R G R G G R B R R) 8

5 (G B R B B R G B B B G B G G B B R R B R G B B G R) 7

6 (R G G B R G B G R B B G R B R R G G B R G B G R R) 9

7 (B B R R B B G R B B R R B B G B B B R B G R B B B) 3

8 (R R B G R B G R B B G G B B G R G B G G G B B G B) 10

9 (B R B G G R G B R R G G G B G R B R B R R B B G G) 9

10 (B G R G B B B R B B G R B R B G R B B B R R R G G) 6

11 (B B R B B B B B R R R B R G G B R R G R R R R B B) 3

12 (B B B B G R B R B B B G B R G B G G B B G R R G B) 7

13 (B B B B B B B R G B G B R B G R G R G G R R G B R) 7

14 (B R B B B B B G G B R R G G R G B R B G R B G B B) 7

15 (B B G R G B R G B B B G B R R G R G G G R R R R B R) 7

16 (B B B G G G G B G B R B R R G B G G G G G R R G R B) 11

17 (G G B R B R R B B R R R B B B B B B B R B G G R B B) 4

18 (R B G G G B B R B G G R G R G G G R G G B B R B B G) 11

19 (B G G R B B R G G R G R G R G B B B B R R G G R B) 9

20 (B R R B G R G R G G G R R R G R R B R R R G B G B) 8

21 (G R G B B G B G R B B B B B R B R B R B R G G B B) 6

22 (G G B B B B G B B R B R R R B R B B G R R R G B R) 5

23 (G R G G G B G G G G B R R B G B B G B G R B B B G) 12

24 (B R G G G R G B B B B B B G G B R R B R G R B B G) 8

25 (B R B G G B R G R R B R R R G G G R B B B R G G G) 9

26 (G G R B B R R G R R R G G R G R B B G B G B G B R) 9

27 (G G B G R B G G R G B B G G G R B G R G G B B B G) 13

28 (B B G G G G G G B B G R R R G G R G G G R R R G B G) 13

29 (R B G R G R R R R G R B G R G R R R G B R B R B B) 6

30 (B R B G B B B G G B G B B R G R R G B B B G G G G) 10

31 (R R G R B B B G R G B G B G B G G R R G G G B G G) 12

32 (R B G B G B G B R G G R G R G G G R R R B G R G B R) 10

33 (G B R R G G B R B R G G R G G R B R R G G R R G R) 10

34 (B R G R B R B B G G R R G B G G G G G G B B G B B B) 10

35 (G G B B G G B R B R G G G G R R G B B G R B R G B) 11

36 (B B R G B G B G B B B G R R B G G R B R R R R B B) 6

37 (G B G B G R R B R B G G R G B G R G G G R R R R R) 10

38 (B R B R G R R B R B R B G B B B G B B R B G G R R) 5

39 (B R R B R R B G B R B G B G R G R B R B B G G B R) 6

40 (R R G R G B R R B R R B B R R B B B R B G R G R R) 4

41 (B R G B R B G B G R R R G B R B R B B G G G G R G) 9

42 (G B B G G R B G R G R G G G B R G R R B R G B R B) 10

43 (R R B G R R R G B R R G R R G R R G G G G R R R B) 8

44 (G B R R B G B R G B R B G R R G G B G B R B B B G) 8

45 (G G B B G G R B R R G R G R G G B G R G B R R R R) 10

46 (R B G G R R R R R B G R R G G B G R G R G G R R R) 9

47 (R G B R B R G B B G B B R G G G B R G G R B R B R) 8

48 (B G G R G B R G R R G B B R G B G R B G G B G B G) 11

49 (R R B B R G B G R B B G R R R B R G B R R R R R G) 5

50 (B R B R R G G R B B B R G B B G R R R B G R B B R) 5

51 (B B G G R B B R R R B R G R B B B B R G B R B R B) 4

52 (G G R B R G G G R B G B B B R G R R B G B R B G R) 9

53 (G G R R R B G B G B B R B G B R G R R R G G G B R) 9

54 (G G G B B G G R R R G G B R B R B R G G B G R R B) 10

55 (R R R R G G B G G G G R B B B R B B G B G G R B B) 9

56 (G R G R R G B G B G R G B R G R R G G R B G R G B) 11

57 (G R G G R B B R G G B R R B B G R G G R B G B R G) 10

58 (G R R B R R R R R G R B G G B R R G G R R R G G B) 8

59 (R R R R R G R R G B B B B B R R B B R G B R B R R) 3

60 (B R B B R R G G G B R B G G R G G B B R R R R G B) 8

61 (B R G R B R B G R R G R G B R G G B G G G B G B B G) 10

62 (B R G R G B G G G G G B R B B R G R G B G R R G R) 11

63 (B B G G G B B R R G B B G G G G R B G B R B R B B) 9

64 (B R R R R G R G B G G B B G B B G B B G B R B B G) 8

65 (B B B B G B B R G R G G G B R R B G G G R R G R G) 10

66 (R R B G R R G G R B R B G G G R R R B R R R G G G) 9

67 (R G G G R R G R R G R G B R G R R G R R B B R G R) 9

68 (R B R R B B B B R B B G G G G B G R R R G G B B R) 7

69 (G G G B B G B B B G B B G G R G B R G B B B B R G) 10

70 (R R G G G G R R R B G R R R G B G R G R R B R G B) 9

71 (R B R R R R B R R B B B R R R G B R B R R R R R B) 1

72 (B B B G G B B G G G R R G G R B R R R R G G R B R) 9

73 (B B B B G R R R G R B R R R G G G G B R B B G B R) 7

74 (R B R B R R B R R B G R G B G R B B R G B B R R G) 5

75 (R G G B B R B R B B R G G G R R R R R R G B G G R) 8

76 (R B B B R G R G B B G R R G G G G G G G R B G G G) 13

77 (B B G B R R B G R B G G B B B R G R R B B B G B R) 6

78 (G G G G R B R B G B R R B G G R G R G G B B G R R) 11

79 (R B G B G R R R G B R G G R G G B B B B G R B B R) 8

80 (B B B G G R R B B R R B R B R B R R B B G R G B R) 4

81 (R G R R B R B R R B G B R R B G G B B G R B B R G) 6

82 (R B G R G B B G R R B G B B R R G G G G R R B R B) 8

83 (G B R R G G B R G B B G G G B B R B B B R B B R B) 7

84 (G G G B G B R G R B G R B G G B B R B G R G G G B) 12

85 (R R R R B R B G R G G B R B R R B R R R R G G B B) 5

86 (B R G B G R B R R B B G R G G B G R R R G R R G R) 8

87 (B R R B B R B B B G G R B G G B R R B R R R R G G) 6

88 (B G G R B R G B B B G B R R G B G R G G B R R B B) 8

89 (G R R R G B R B R B B R B G R G R R R G G G R R B B) 6

90 (R R R B B R R G R G B B G B R G R G B G G B G B R) 8

91 (R R B R R G B B R R G B G G B G G B G G G R R R R) 9

92 (B B G R G B G G G B G B R B G G R R B G G R B B G) 11

93 (B B G R G R G B G B B R B B G G G R R G R G G B R) 10

94 (B G R G G G G R R G R G R G R G G G R B R R G B B) 12

95 (B B G G B B B B R G R G G B G G G B G R G G B B R) 11

96 (G R R B G R G G G G R B R R G B R G G R R R B G G) 11

97 (B R G R B B B G B G B R G B G G G R R B R G G G B) 10

98 (G R B G B G G G B R G R B B G G R R B G R B R G G) 11

99 (G G B B R G R R B R B R B G G R G G G G G B R B R) 10

100 (B R G B G B G R B G B G R B R R G R R B B R B B R) 6

average fitness of populatioon 0 = 8.31

average fitness of populatioon 1 = 11.4

average fitness of populatioon 2 = 13.43

average fitness of populatioon 3 = 15.49

average fitness of populatioon 4 = 16.93

average fitness of populatioon 5 = 17.81

average fitness of populatioon 6 = 18.86

average fitness of populatioon 7 = 19.84

average fitness of populatioon 8 = 20.65

average fitness of populatioon 9 = 21.38

average fitness of populatioon 10 = 21.74

average fitness of populatioon 11 = 22.2

average fitness of populatioon 12 = 22.87

average fitness of populatioon 13 = 23.55

average fitness of populatioon 14 = 23.81

average fitness of populatioon 15 = 24.23

average fitness of populatioon 16 = 24.48

average fitness of populatioon 17 = 24.54

average fitness of populatioon 18 = 24.52

average fitness of populatioon 19 = 24.5

average fitness of populatioon 20 = 24.59

average fitness of populatioon 21 = 24.52

average fitness of populatioon 22 = 24.52

average fitness of populatioon 23 = 24.5

average fitness of populatioon 24 = 24.51

average fitness of populatioon 25 = 24.53

Generation 25 population ...

1 (G G G G G G G G R G G G G G G G G G G G G G G G G) 24

2 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

3 (G G G G G G G G G G G G G G G G B G G G G G G G G) 24

4 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

5 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

6 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

7 (G G G G G G G G G G G G G G G R G G G G G G G G G) 24

8 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

9 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

10 (G G G G G B G G G G G G G G G G G G G G G G G G G) 24

11 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

12 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

13 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

14 (G G G G G G G G G G G G G G G G G G G G G B G G G) 24

15 (G G G G G G G G G G G G G G G G G G G G G G G G B) 24

16 (G G G G G G G G G G G G G G G R G G G G G G G G G) 24

17 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

18 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

19 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

20 (G G G G G G G G G B G G G G G G G G G G G G G G G) 24

21 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

22 (G G G B G G G G G G G G G G G G G G G G G G G G G) 24

23 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

24 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

25 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

26 (G G G G G G G R G G G G G G G G G G G G G G G G G) 24

27 (G G G G G G G G G G G R G G G G G G G G G G G G G) 24

28 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

29 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

30 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

31 (G G G G G G B G G G G G G G G G G G G G G G G G G) 24

32 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

33 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

34 (G G G R G G G G G G G G G G G G G G G G G G G G G) 24

35 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

36 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

37 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

38 (G G G G G G G G G G G G G G G G G G G G G G G B G) 24

39 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

40 (G G G G G G G G G G B G G G G G G G G G G G G G G) 24

41 (G G G G G G G G G G G G G G G G G G G G G G G G R) 24

42 (G G G G G G G G G G G G G G G G G G G G G R G G G G G) 24

43 (G G G G G G G G G G B G G G G G G G G G G G G G G) 24

44 (G G G G G G G B G G G G G G G G G G G G G G G G G) 24

45 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

46 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

47 (G G G G G G B G G G G G G G G G G G G G G G G G) 24

48 (G G G G G G G G G G G G G G G G G G G G G G G B) 24

49 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

50 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

51 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

52 (G G G G G G G G G G G G G G R G G G G G G G G G G) 24

53 (G G G G G G G G G G G G G B G G G G G G G G G G G) 24

54 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

55 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

56 (G R G G G G G G G G G G G G G G G G G G G G G G G) 24

57 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

58 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

59 (G G G G G G G G G G G G G G G G G G G G G G G R G G) 24

60 (G G G G G G G G G G G R G G G G G G G G G G G G G) 24

61 (G G G G G G R G G G G G G G G G G G G G G G G G G) 24

62 (G R G G G G G G G G G G G G G G G G G G G G G G G) 24

63 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

64 (G G G G G G G G G G R G G G G G G G G G G G G G G) 24

65 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

66 (G G G G R G G G G G G G G G G G G G G G G G G G G) 24

67 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

68 (G G G G G G G G G G G G G G G G G R G G G G G G G) 24

69 (G G G G G G G G G G B G G G G G G G G G G G G G G) 24

70 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

71 (G G G G G G G G G G G G G G G G G G G G G B G G G G) 24

72 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

73 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

74 (G G G G G G G G G G G G B G G G G G G G G G G G G) 24

75 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

76 (G G G G G G B G G G G G G G G G G G G G G G G G G) 24

77 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

78 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

79 (G G G G G G G G G G G G G G G R G G G G G G G G G) 24

80 (G G G G G G G G B G G G G G G G G G G G G G G G G) 24

81 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

82 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

83 (G G G G G G G G G G G G G G G G G G G G G B G G G) 24

84 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

85 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

86 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

87 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

88 (G G G G G G G G G G G G G G G G G G G G G R G G G) 24

89 (G G G G G G G G G G G G G G B G G G G G G G G G G) 24

90 (G G G G G G R G G G G G G G G G G G G G G G G G G) 24

91 (G G G G G G G G G G G G G R G G G G G G G G G G G) 24

92 (G G G G G G G G G G G G G G G G G B G G G G G G G) 24

93 (G G G G B G G G G G G G G G G G G G G G G G G G G) 24

94 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

95 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

96 (G G G G G G G G G G G G G G G G G G G G G B G G) 24

97 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

98 (G G G R G G G G G G G G G G G G G G G G G G G G G) 24

99 (G G G G G G G G G G G G G G G G G G G G G G G G G) 25

100 (R G G G G G G G G G G G G G G G G G G G G G G G G) 24

average fitness of populatioon 25 = 24.53

Task 11 Code:

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;-----------------------------------------------------------
; Task 11 The GA

;; THE NEXT GENERATION METHOD FOR THE GA

( defmethod next-generation ( ( cp population ) &aux np )
    ( setf np ( empty-population cp ) )
    ( perform-copies cp np )
    ( perform-crossovers cp np )
    np
)

;; THE GA!
( defconstant *nr-generations* 25 )

( defmethod ga ( &aux p )
    ( format t "THE WORLD IS BLUE ~%~%" )
    ( setf *fitness* #'fitness-b )
    ( setf p ( initial-population ) )
    ( terpri )
    ( summarize p )
    ( dotimes ( i *nr-generations* )
        ( setf p ( next-generation p ) )
        ( check-average p )
    )
    ( terpri )
    ( summarize p )
    ( format t "THE WORLD IS RED ~%~%" )
    ( setf *fitness* #'fitness-r )
    ( setf p ( initial-population ) )
    ( terpri )
    ( summarize p )
    ( dotimes ( i *nr-generations* )
        ( setf p ( next-generation p ) )
        ( check-average p )
    )
    ( terpri )
    ( summarize p )
    ( format t "THE WORLD IS GREEN ~%~%" )
    ( setf *fitness* #'fitness-g )
    ( setf p ( initial-population ) )
    ( terpri )
    ( summarize p )
```

```
    ( dotimes ( i *nr-generations* )
        ( setf p ( next-generation p ) )
        ( check-average p )
    )
    ( terpri )
    ( summarize p )
)

;; METHODS TO PROVIDE INFORMATION ON "PROGRESS"
( defmethod summarize ( ( p population ) )
    ( display p )
    ( check-average p )
    ( terpri )
)

( defmethod check-average ( ( p population ) )
    ( format t "average fitness of populatioon ~A = ~A~%"
        ( population-generation p )
        ( average p )
    )
)
```